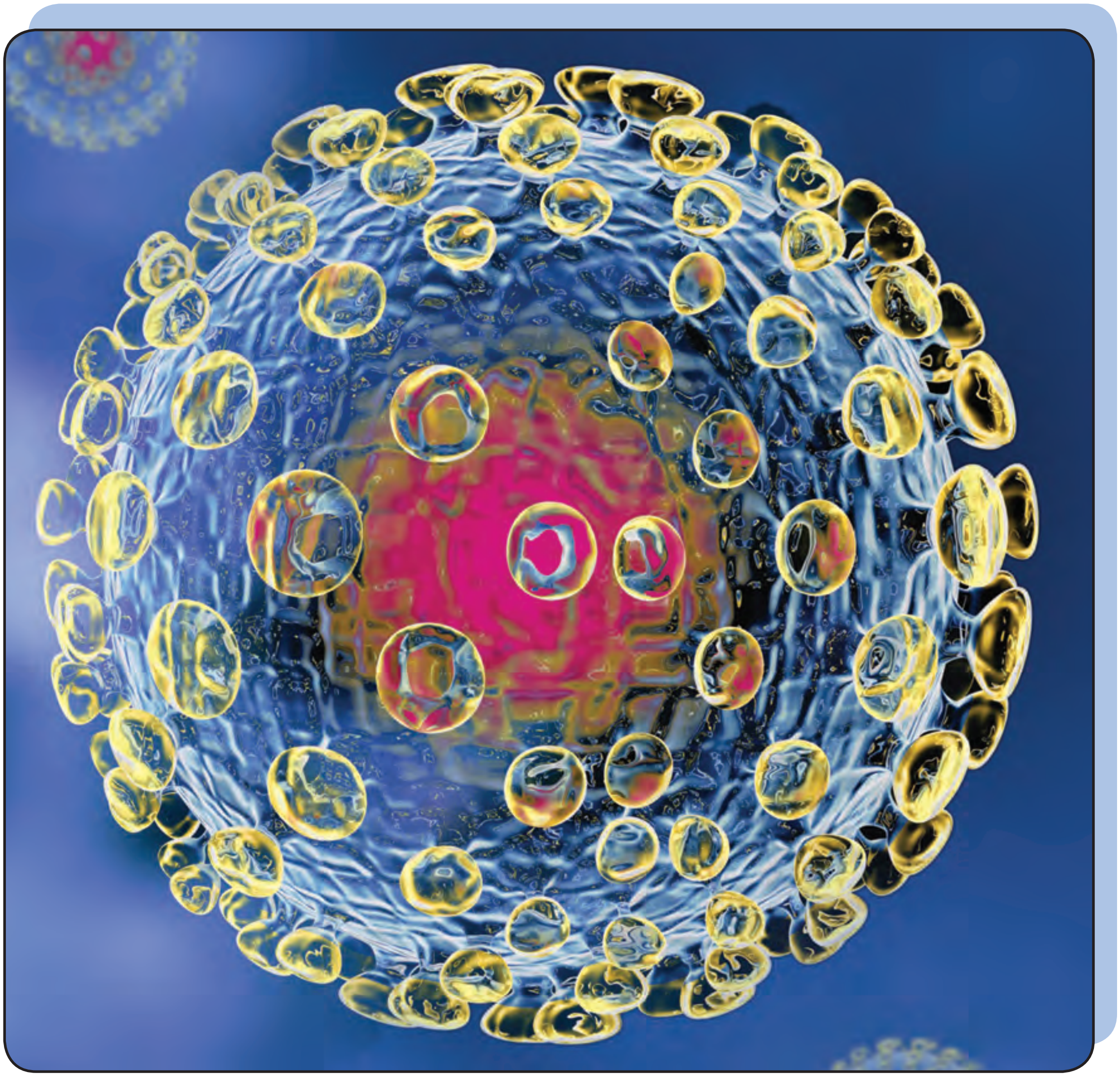
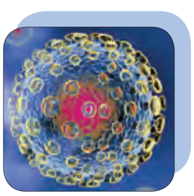
Chapter 1





HEREDITY AND EVOLUTION

1. HEREDITY AND EVOLUTION

HEREDITY AND VARIATION

A cow gives birth to a calf. Both the mother cow and calf share common characteristics like body design, physiological function etc, that are specific to their species. However on a very close observation of the mother cow and the calf and the bull which is the calf's other parent , we will come across a number of differences among them, like colour pattern in the skin. By virtue of being the progeny of the parent, the progeny individual, need not just be the replica of what its parents are. (Inheritance of characters from the parents to the progeny (i.e. , Heredity) ensures the passing of the parental characters to the progeny). The difference or change in the characteristics between the individuals is called Variation. Human population shows a great deal of variation.

ACTIVITY 1.1

- Ask your classmates to roll their tongues. Observe how many can and how many are not able to roll their tongues. Record your findings.
- Similarly record the variation in the eye colour noticed among your classmates.

1.1. HEREDITY

The progeny produced through the reproductive process is similar to its parents, in body design, function etc., The rules of heredity determine the process by which the traits and the characteristics are relatively inherited.

"The inheritance of characteristics through generation is called heredity"

The inheritable characteristics may be morphological/anatomical/physiological/ reproductive and are also known as traits.

If we take a very close look at the rules of inheritance, both father and mother contribute equal amount of genetic material to the child. This means that each trait can be influenced by both paternal and maternal genetic material – i.e, DNA.

Gregor Johann Mendel (1822-1884) worked out the first ever scientific experimental study on heredity.

Mendel, an Austrian Augustinian monk observed variations in the characteristics of garden pea plant (Pisum sativum) which he had cultivated in his monastery garden. Mendel was curious to find out the results of crossing of pea plants with the variation in traits. The visible contrasting characters that Mendel observed in the garden pea plants were

- Seed shape - Round/Wrinkled
- Seed colour - Yellow/Green
- Flower colour - Violet / White

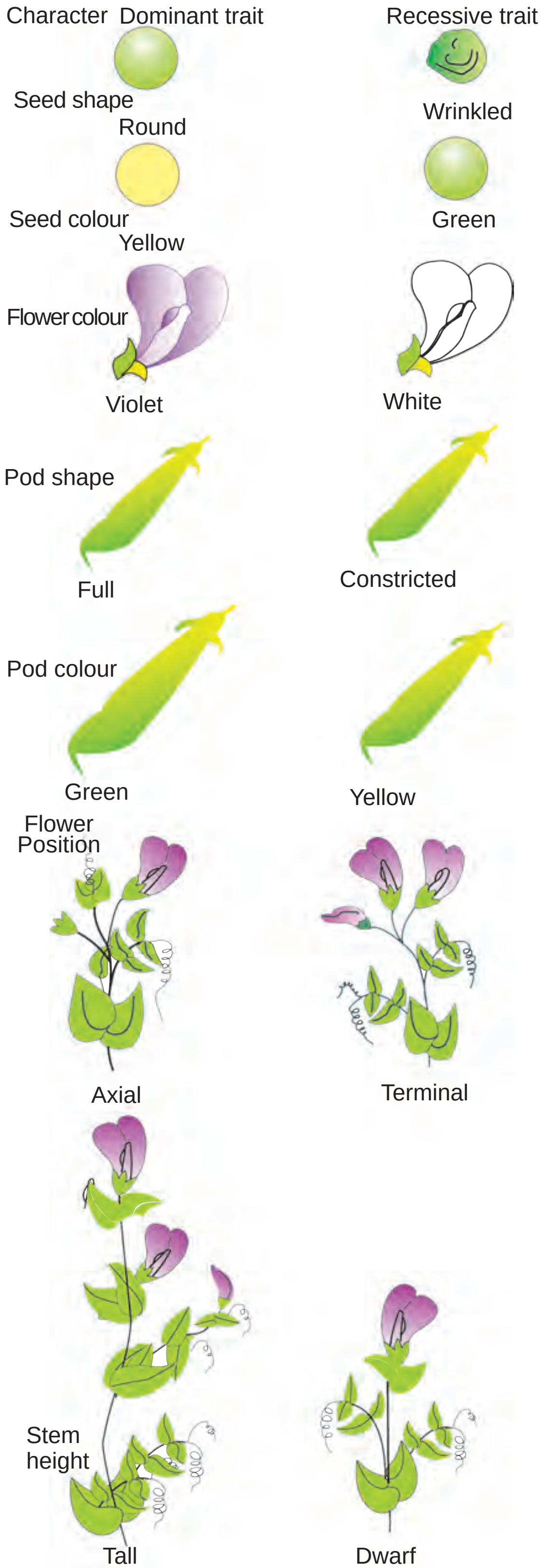


Fig. 1.1 Seven pairs of contrasting traits in Pea plant studied by Mendel.

- Pod shape - Full / Constricted
- Pod colour - Green / Yellow
- Flower position - Axillary / Terminal
- Stem height - Tall / Dwarf

1.1.1. Mendel's monohybrid cross

Mendel selected the garden pea plant, Pisum sativum for his experiments. He selected tall and dwarf plants and allowed them to grow naturally. As pea plants produce seeds only by self pollination, he observed that tall plants produced always

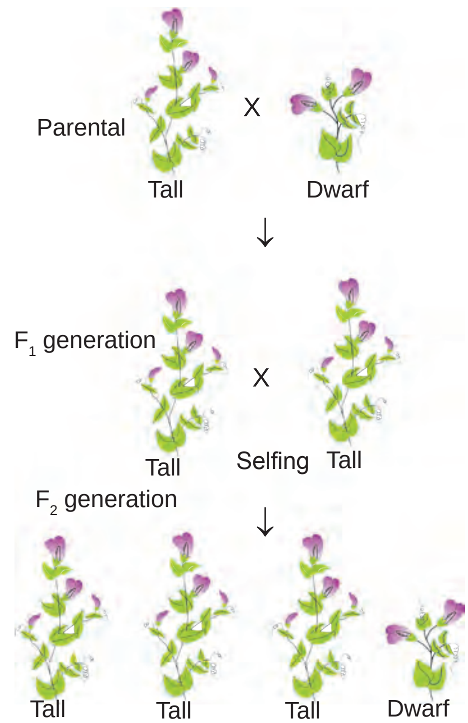


Fig. 1.2 Diagrammatic representation of Monohybrid cross

tall plants generation after generation under natural condition.Similarly, dwarf plants produced always dwarf plants generation after generation. Hence, he termed the tall and dwarf plants as wild types or pure breeding varieties.

Then he crossed a tall plant with a dwarf plant, produced progeny and calculated the percentage of tallness and dwarfness in subsequent generations.

When a pure breeding tall plant was crossed with a pure breeding dwarf plant, all plants were tall in the first filial generation (F1) i.e., there was not any medium height plants or dwarf plants. This means that only one of the parental traits were seen and not the mixture of the two. When such a F1 tall plant was allowed to have self pollination, both the tall and dwarf plants appeared in second filial generation (F2). in the ratio of 3:1. This indicates that both tallness and dwarfness were inherited in the F1 plants but only tallness trait was expressed.

Gregor Johann Mendel(1822-1884)

Mendel was educated in a monastery and went on to study science and mathematics at the university of Vienna. Failure in the examinations for a teaching certificate did not suppress his zeal for scientific quest. He went back to his monastery and started growing peas. Many others had studied the inheritance of traits in peas and other organisms earlier, but Mendel blended his knowledge of Science and Mathematics and was the first one to keep count of individuals exhibiting a particular trait in each generation. This helped him to arrive at the laws of inheritance that we have discussed in the main text.

ACTIVITY 1.2

Observe in your locality for plants which show different characters for the following traits. Count them and record your findings. Examples:

Coconut	Tall	Dwarf
Bean	Violet Flower	White Flower
Sugar Cane	White Stem	Purple Stem
Clitoria	Blue Flowers	White Flowers

The first experiment of Mendel considering the inheritance of a single trait (Height of the plant Tall/Dwarf) is called Monohybrid Cross.

Expression of morphological characters as tall or dwarf plant, violet or white flower is called Phenotype.

The expression of gene (or Chromosomal make up) of an individual for a particular trait is called Genotype.

1.1.2. Physical basis of heredity

The genotype of a character is influenced by factors, called Genes. The genes are the factors which form the physical basis for inheritance of Characters. The alternate expressions of the same gene are called alleles. The contrasting pair of alleles make up an allelomorph. Examples : Tall and

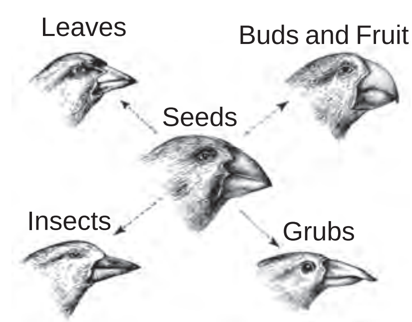


Fig. 1.3 Variations in the beaks of finches to suit their eating habits.

ACTIVITY 1.3

Find out identical / Non-identical twins in your school and locality. Find the minute variations between them.

dwarf plants, wrinkled and smooth seed coat, white and violet coloured flower. Organisms differ or vary in expressing phenotype which leads to variation.

1.2. VARIATION

All around us , we see different organisms belonging to different species, differing from one another. Variation may be defined as the differences in the characteristics among the individuals of the same species (intra specific variation) or among the different genera

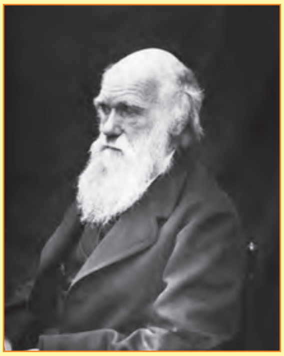
Fig. 1.4 Identical twins

(intergeneric variation) or different species (Inter specific Variation). No two individuals are identical to each other. Asexual reproduction produces, very closely resembling offsprings. Asexual reproduction thus results in offsprings with minor variations.Sexually reproducing organisms produce offsprings with marked,significant and visible variations.

1.2.1. Types of variations

a. ***Somatic Variation*** - It pertains to bodycells and it is not inherited.

Charles Darwin: *(1809-1882) Charles Darwin set out on a voyage when he was 22 years old. The 5 year voyage took him to South America and the islands, off its coast. Interestingly, after he got back to England, he never left to the shores again. He stayed at home and conducted various experiments that led him to formulate his hypothesis*



from which evolution took place due to ral selection. He did not know the mechanism from where the variations arose in the species. Had he been enlightened by Mendel's experiments, he would have contributed more. But these two great men did not know of each other or of their works!

We often associate Darwin solely with the theory of evolution. But he was an accomplished naturalist, and one of the studies he conducted was, to do with the role of earthworms in soil fertility.

b. ***Germinal Variation*** - It pertains to germ cells or gametes and it is inheritable. It leads to speciation and evolution.

Significance of Variation

- It is the source of raw material for evolution.
- Animals are able to adapt themselves to the changing environment.

Lamarckian View on organic evolution:

Fig. 1.5 Giraffe

Jean Baptise Lamarck (1744-1829) postulated the Use and Disuse Theory. According to Lamarck, use of a part / organ efficiently by a species, for generations over a long period of time, results in that part / organ being well developed in the subsequent generations and disuse of part/organ for a long period would make that part / organ diminished or degenerated.

Lamarck quotes the example of development of long neck of Giraffe. Giraffes were forced to extend their neck and stretch their legs to reach the leaves of tall trees. Over a long period of time, this resulted in long neck and legs in giraffe. Lamarck remarks that the "will or want" for a character makes the organisms to posseses it at a later time.

- Organisms are better suited to face the struggle for existence
- Variations give the organisms an individuality of their own.
- Without variation, there would be no science of heredity as all individuals of a race, would be identical in all aspects.

1.2.2. Theory Of Natural Selection

Charles Darwin made a number of observations in many parts of the world and put forth the law of natural selection involving struggle for existence and survival of the fittest.

Variation leads to genetic diversity,which is the key for evolution.

1.3. EVOLUTION

Evolution may be defined as a gradual development of more complex species from pre-existing simpler forms.

It is an extremely slow process and has occurred over millions of years,as revealed by fossil evidences.

Evolution has thus resulted in the diversity of organisms, influenced by environmental selection.

1.4. SPECIATION

Mankind in India and all other parts of the world, form a single species called Homo sapiens. As in India, morphological features of people living in different geographical areas like South India, North India, North Eastern region, Kashmir and Andaman are not the same as the people living in different continents are different in morphological features.

Men, with these differences in their bodily features, differentiate more and more, if there is no chance of interbreeding among them.

Imagine a situation, where this would result in the impossibility of

breeding between two such individuals of geographically isolated populations. Then they would be ready to become two different species.

When two populations are isolated by geographical barriers, or reproductive barriers, there is a chance for a change to develop in their gene flow (Genetic drift), leading to formation of a new species. Genetic drift with changes in the gene flow imposed by isolation mechanism acts as an agent of speciation.

Thus speciation is arising of a new species from a sub-population of a species which is geographically or reproductively isolated over a long period of time from the other population of the same species.

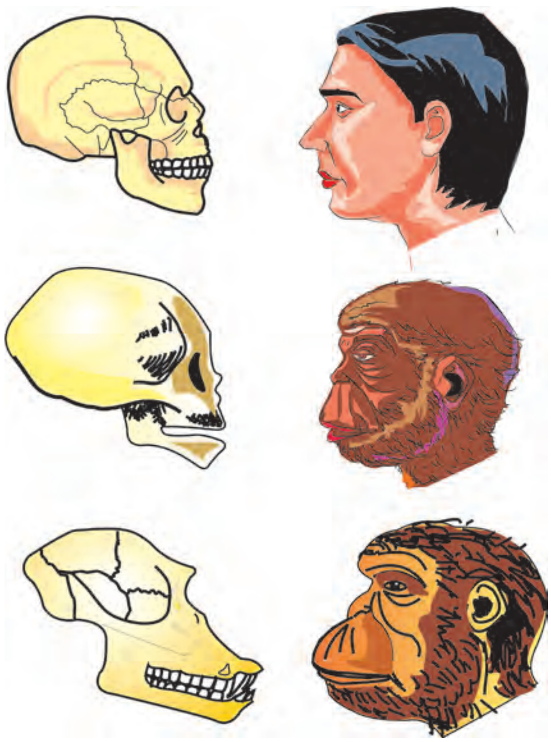


Fig. 1.6 A comparison of the skulls of adult modern human being, baby chimpanzee and adult chimpanzee. The skull of baby chimpanzee is more like adult human skull than adult chimpanzee skull.

1.5. HUMAN EVOLUTION

Fifteen million years ago, in Africa existed hairy bodied Gorilla and Chimpanzees like Hominids. After that 3-4 million years ago, men like hominids, walked into Eastern Africa. Evidence shows that they hunted with stone weapons but were mostly fruit eaters. They were probably not taller than four feet but, walked upright in the grass lands of East Africa. These creatures were called the First human like being – the hominid. The hominid was called Homo habilis.

The next stage of human evolution came into existence 1.5 million years ago with the rise of Homo erectus who were meat eaters

The Neanderthal man who lived in East and Central Asia 1 million years

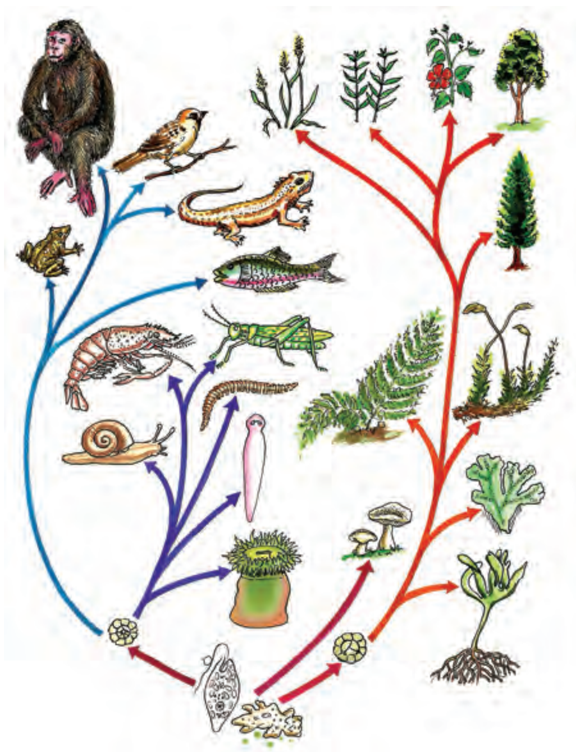


Fig. 1.7 Evolutionary tree

ago, used to hide to protect them and buried their dead.

Archaic Homo sapiens arose in South Africa and moved across continents and developed into distinct races during the ice age. Between 75,000 – 10,000 years, the modern Homo sapiens arose. Pre-historic caves were developed about 18,000 years ago, agriculture came around 10,000 years back and human settlements started.

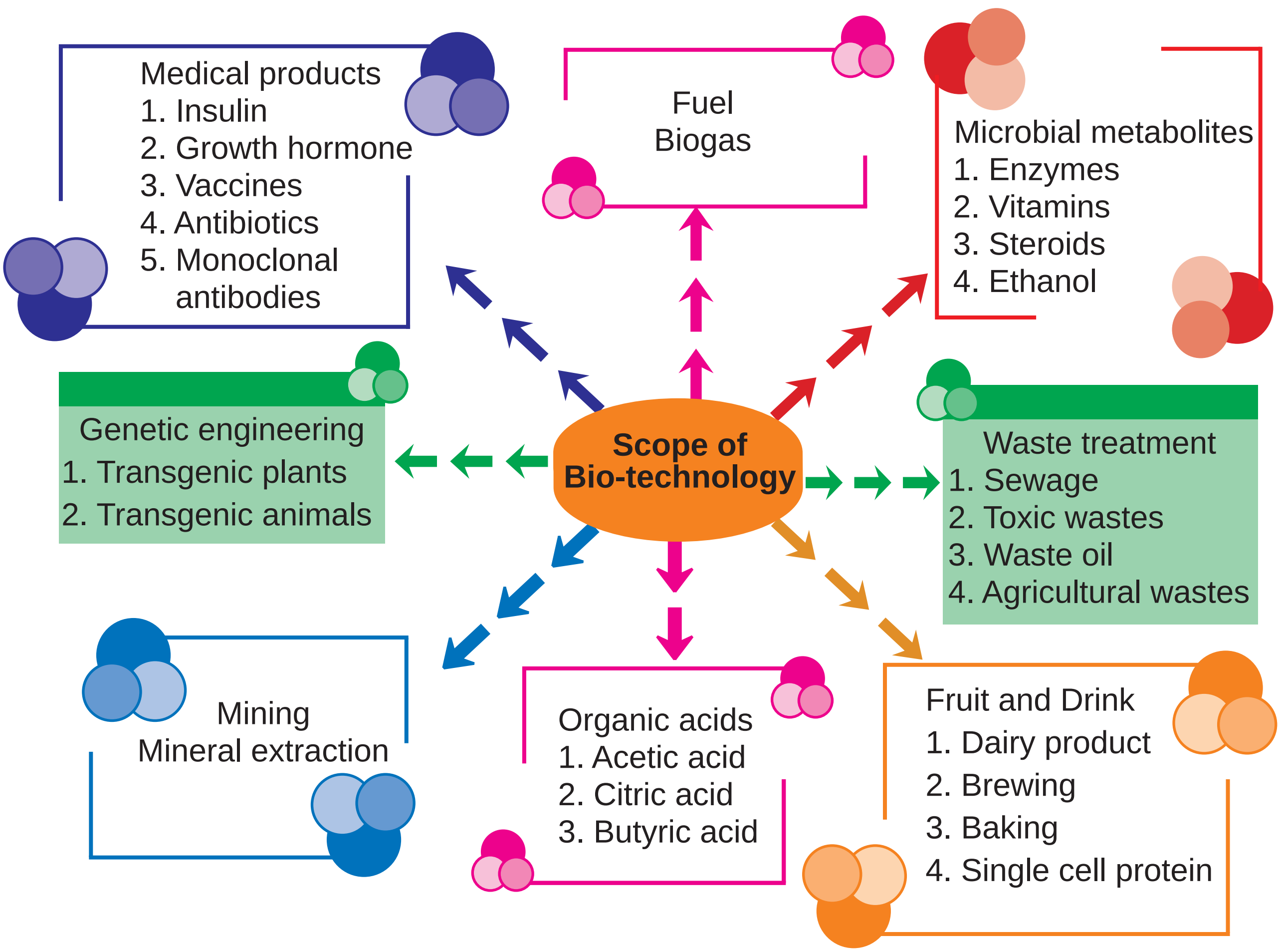
1.6. EVOLUTION TREE

To understand evolution, a branching diagram or "Tree" is used to show the inferred evolution, relationships, among various biological species or other entities based upon similarities and differences in their physical and genetical characters.

1.7. GENETIC ENGINEERING

Genetic engineering is the modification of the genetic information of living organisms by manipulation of DNA by adding, removing or repairing part of genetic material (DNA) and changing the phenotype of the organism. It is also known as gene manipulation or recombinant DNA Technology (r-DNA Technology)

Recent advances made in Genetics, Molecular Biology and Bio-Chemistry have resulted in the origin of this new branch of science. The benefits derived through the Genetic Engineering include:



- Understanding of the gene structure and function through basic research.
- Production of large quantities of insulin, interferon(Anti-Viral Protein produced by Virus infected cells) human growth hormones, proteins (Polypeptides) and vaccines for foot and mouth disease of cattle (komari – in Tamil) etc.,
- This technique is also employed in the transfer of genes involved in Nitrogen fixation(NF–genes). This will help the cultivator to increase productivity.

1.7.1. Basic techniques in Genetic Engineering

Genetic Engineering has developed after the discovery of two enzymes. The enzymes which can cut DNA into fragments, and enzymes which can join such fragments.

Restriction enzymes or Restriction endonucleases are molecular scissors which cut DNA at specific sites. DNA ligases are the paste enzyme which helps to join the broken DNA fragments.

1.8. BIO-TECHNOLOGY AND CLONING

Bio-technology has contributed towards exploitation of biological organisms or biological processes through modern techniques which could be profitably used in medicine, agriculture, animal husbandry and environmental cleaning. There are several applications of Bio-technology such as brewing Industry, enzyme technology, manufacturing of anti-biotics, organic acids, vitamins, vaccines, steroids and monoclonal anti-bodies.

It was Edward Jenner (1749-1823) in 1791 who coined the term vaccine and the term vaccination for protective inoculation. Vaccines produced by Bio-technology differ from others. In that, they do not contain weakened or killed agents. Instead they are so refined as to consist only the reactive material ie., the antigen protein only. The first such vaccine was used against Hepatitis B Virus (HBV)

Edward Jenner

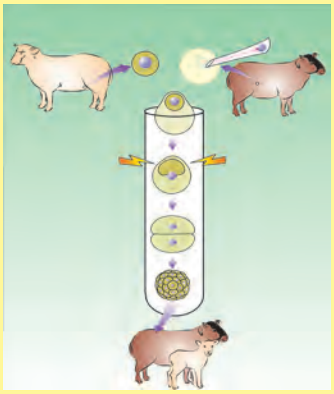
Brewing Industry: Fermentation in alcoholic beverages like beer, wine etc.,

Enzyme Technology : Enzymes are bio-catalysts that speed up reaction in cells. They can be used to catalyze the industrially important reactions and are more efficient than inorganic catalysts. Many enzymes are utilized in the pharmaceutical industry.

Anti-Biotics : These are substances produced by some microbes that help in increasing the immunity to human beings which are toxic to other micro-organisms.

Organic Acids: Acetic acid is used for the production of vinegar.

Development of Dolly



Cloning

Dolly was a cloned sheep, developed by Dr.Ian Wilmut and his colleagues in Roselind Institute in Scotland in July 1996.

The scientists used nucleus of udder cell (somatic cell taken from mammary gland) from a six year old Finn Dorset white sheep.

The nucleus of the udder cell contains, diploid number(2n) of chromosomes with all the genes. They preserved the diploid nucleus in a suitable preservative. Then they took an ovum from the ovary of another sheep. The haploid nucleus (n) in the ovum was removed.

The diploid nucleus of the udder cell was injected into the cytoplasm of the enucleated ovum. Then the ovum with the diploid nucleus, was implanted into the uterus of the surrogate mother sheep. Since the ovum had the diploid nucleus, it developed into a young clone. It was named "Dolly" by Dr.Ian Wilmut.

Vitamins: These are chemical compounds present in variable minute quantities in natural food stuffs. They do not furnish energy but are very essential for energy transformation and regulation of metabolism.

Fig. 1.10 Dr. Ian Wilmut with dolly

Vaccines: Vaccines are substances that confer immunity against specific disease. They act as antigens and stimulate the body to manufacture antibody.

Steroids: They are a type of derived lipids Ex: Cholesterol, containing steroid drugs like prednisolone is produced from fungus Rhizopus.

Monoclonal anti-bodies : These are the anti bodies produced by cloned cells. Monoclonal anti -bodies, are now used for treatment of cancer.

Cloning: Cloning is an experimental technique wherein a group of morphologically and genetically identical organisms are produced. The "Clone" is an organism derived from a single parent by asexual method. A clone may be defined as an exact carbon copy or copies of a single parent.

The word clone refers only to living species.

If the cloning technique is to be applied to veterinary science, valuable

animals could be cloned from desirable adult cells.

1.8.1 Types of Clones

Natural clones: The natural clones include identical twins.

Induced clones: The induced (artificial) clones are developed by nuclear transfer into the host cell

1.9. STEM CELL (ORGAN) CULTURE:

One of the most fascinating branches in applied embryology is stem cell culture. The stem cells are the most unspecialized mass of cells. They are derived from animals and plants. They have two important characteristic features. They are:

1. Unspecialized cells which have the potentiality of growing and multiplying into enormous number of same type of cells by repeated mitosis.

2. They can be introduced to become any other type of tissues with specific functions i.e., they can be induced to become a cardiac muscle, beta cells of pancreas (which produce insulin), special neurons in brain etc.,

1.9.1. Types of Stem Cells

There are two kinds of stem cells

1. ***Embryonic Stem Cells:*** The embryonic stem cells can be derived from early embryo which is developed by "invitro fertilization" (fertilisation made artificially in the laboratory).

After fertilization the zygote develops into a hollow blastula by cell division. The inner mass of undifferentiated cells are isolated and they are considered as embryonic stem cells.

2. ***Adult or Somatic Stem Cells***: The body of higher animals and human beings have many well differentiated tissues like epithelial, connective, muscular, vascular, supporting, nervous and reproductive tissues. In these tissues, there are some undifferentiated cells and are considered as the adult or somatic stem cells. They can grow, multiply and can be differentiated into same type of tissues into which they are implanted. The mechanism of adult or somatic stem cell culture is similar to that of embryonic stem cell culture. The somatic stem cells are derived from sources such as bone marrow, embryos, amniotic fluid and umbilical cord.

1.10. MICROBIAL PRODUCTION

As we discussed earlier, the field of Bio-technology is so vast and has great scope for different fields like agriculture, medicine, foodindustry etc.,

The microbial products of every day use are:

Vaccines : Killed or live germs suspension which is employed to induce the production of antibodies and bring forth immunity.

Antibiotics : Antibiotics are chemical substances derived from microbes like fungi, bacteria etc., employed to kill the infectious germs and cure a disease.

Vitamin B_{12} : Bio technologically synthesized vitamin B_{12} is used, to cure pernicious anaemia.

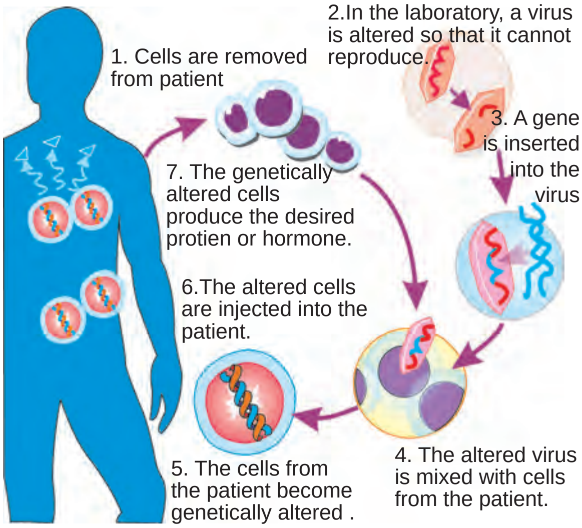


Fig 1.11 Gene therapy

Enzymes : Bio-Chemically significant enzymes are derived from microbes \ Ex. Amylase is derived from amyloproteins of bacteria.

Insulin : Diabetes is treated by the biotechnologically produced insulin.

1.11. BIO-SENSOR AND BIO-CHIPS

Bio sensor: It is a device consisting of immobilized layer of biological material such as enzyme, antibody, hormone, nucleic acids, organelles or whole cells and its contact with a sensor. The sensor converts biological signals into an electrical signal. It is used in medicines and industry.

1. Blood glucose level can be detected.
2. Production of any toxin in the body due to infection can be detected.
3. Pollution in drinking water can be monitored.
4. Odour, freshness and taste of food can be measured.

Bio-Chips

Bio-Chips are microchips which are developed by employing techniques of Bio-technology. In future, biological computers will be developed using bio-chips. Bio-Chips will be useful in defence, medicine etc.,

1.12 SCIENCE TODAY - GENE THERAPY

Insulin dependent diabetes is treated with insulin injection. Insulin dependent diabetes is caused by the degeneration of beta cells due to a defective gene. Applying the principle of Bio-technology, it is possible to correct the defective gene. When the defective gene is corrected with a new gene, the genetic defect developed is, rectified and cured.

Gene Therapy is the means to treat or even cure genetic and acquired diseases like cancer and Aids by using normal gene to supplement or replace the defective gene.

It can be used to treat defects in Somatic i.e., (body) or Gametic (sperm or eggs) Cell.

Types of Gene Therapy

1. Somatic gene therapy:- The genome (gene set) of the recipient is changed. But this change is not passed along to the next generation.
2. Germ line gene therapy:- Egg and sperm of the parents are changed, for the purpose of passing the changes to the next generation.

EVALUATION

PART A

1. Mendel observed 7 pairs of contrasting characters in Pisum sativum. One of the following is not a part of that. Find out.

   - Tall and dwarf,
   - Yellow and green seed colour,
   - Terminal and axial Flower,
   - Smooth and rough stem

2. Primitive man evolved in – (Africa, America, Australia, India)

3. Which of the following is inheritable (an altered gene in sperm, analtered gene in testes, an altered gene in zygote ,an altered gene in udder cell)

4. Theory of natural selection was proposed by - (Charles Darwin, Hugo de Vries, Gregor Johann Mendel,Jean Baptise Lamarck)

5. Somatic gene therapy (affects sperm, affects egg, affects progeny ,affects body cell)

PART B

6. Mendel has observed Tallness as dominant character in Garden pea plant. Similarly tongue rolling is a dominant character in man. In a group of 60 students, 45 can roll their tongue and 15 are non rollers.

   a) In the above context, calculate the percentage of dominant and recessive characters.

   b) In Garden pea plant, draw the diagrammatic representation of mono hybrid cross as explained by Mendel.

7. The heritable characters are varying in different species and within the same species.

Name the variation in the following cases.

The eye colour among the human beings are varied as blue, black, brown, green, etc.,

a) This is called as _______variation.
The dentition in rabbit and elephant are not the same.

b) This is called as __________ variation.

8. Sexually reproducing organisms produce offsprings with marked, significant and visible variation.

Asexually reproducing offsprings show minor variations.

a) Do you agree with the above statements?

b) Among the following organisms list out the asexually reproducing organisms.
(Paramoecium, Euglena, Earthworm and Bird).

9. Here is a certain important hereditary jargons, fix a suitable one from the list given below.

a) __________ are the factors which form the physical basis of inheritance.

b)__________ is alternate expression of same gene.

c)__________ are contrasting pairs of alleles.(alleles, variation, speciation, gene, allelomorph)

10. A change that affects the body cell is not inherited. However , a change in the gamete is inherited. Radiation effects of Hiroshima has been affecting generations. Analyzing the above statements, give your interpretation.

11. Sequentially arrange the different species of man from primitive to modern man. (Neanderthal man, Homo habilis, Homo erectus, Homo sapiens)

12. Bio-technology , the modern science in biology, has helped in producing different types of products.

    One of the following group does not have a product of bio-technology. Pick out and give reasons.

    a) Enzymes, Organic acids, Steroids, Vaccines

    b) Vaccines, Enzymes, Anti biotics, Organic acids

    c) Anti biotics, Hormones, Steroids, Vaccines

    d) Steroids, Enzymes, Anti bodies, Vaccines.

13. Identical twins are syngenic with similar chromosomal contents. Natural clones are those who possess identical chromosomes. Fill up with the suitable word given in the bracket.

    a) Identical twins are ___________ (Natural clones / Induced clones)

    b) Identical twins are ____________ (dissimilar to each other / similar to each other).

14. The ancestor of particular type of frog found in India and Srilanka were the same,

    a) With reference to the above map, identify the factor that has resulted in the formation of a new species.

    b) State a few other factors that help in the formation of new species.

PART C

15. Human evolution has a record of changes for the past of 15 milion years.

    a) Name the different species of mankind in chronological order from primitive to modern man.

    b)When were the primitive caves developed.?

    c) Narrate the life led by early man like hominids.

FURTHER REFERENCE

Books: 1. Biology - A Modern Introduction B.S.Beckett, Second Edition, Oxform University Press

Chapter 2

IMMUNE SYSTEM

2. IMMUNE SYSTEM

IMMUNE SYSTEM

"Health is Wealth" is an apt proverb. There can be no wealth greater than the good health that a person enjoys. In a healthy state, a person keeps himself physically, mentally and socially, fit. Our body has a complex defense mechanism to keep itself fit and work against various agents which disturb our well being. Being exposed to diseases, we develop resistance towards diseases and gain immunity.

2.1. HEALTH AND ITS SIGNIFICANCE

"Health is a state of physical, mental and social well being of an individual and not merely absence of a disease or infirmity".

When a person is in good health, the different organ systems, not only function well discharging their duties, but the body as a whole is also able to adjust itself and strike a balance with the physical, mental and social environments.

The varying environmental factors such as temperature, humidity, wind, pressure, sun, rain, pollution caused by man, atomic radiation, malnutrition, the millions of microbes that surround our bodies, the inter-personal conflicts are all other factors affect our lives and are challenges to our health.

Dimensions of Health

1. **Physical dimension :** A person who is free from disease, is bright with his skin shining enjoying normal metabolism, has a good lustrous hair and has no black rings around his eyes.
2. **Mental dimension :** A mentally healthy person who knows his capacities, does not overestimate or underestimate himself and can judge his shortcomings and weaknesses.
3. **Social dimension :** A person

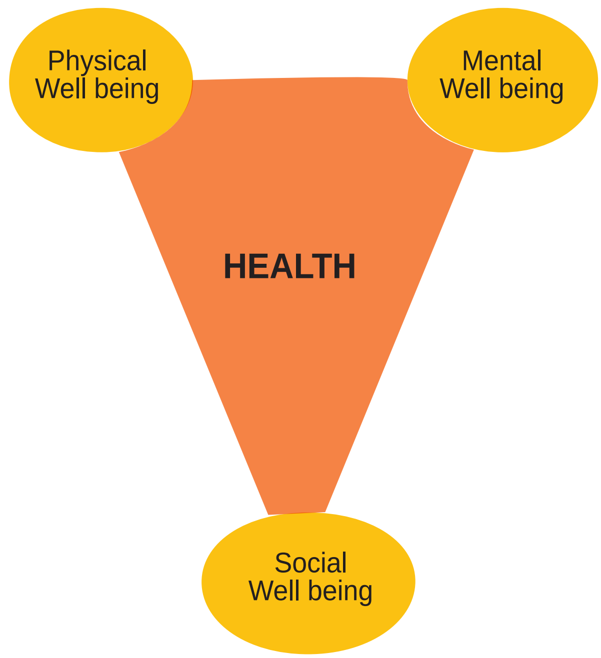


Fig. 2.1 Dimensions of health

adjusting himself in society, does not find fault with others. He maintains interpersonal relationships with his family members and colleagues at workspot and is free from interpersonal conflicts and will not quarrel.

ACTIVITY 2.1

Following the above criteria, make a survey of your classmates/people in your neighbourhood and record your finding

- Number of students/neighbours who are healthy.
- Number of students/neighbours who do not have good interpersonal relationship and do not enjoy social well being.
- Number of students/neighbours who have diseases affecting their metabolism.
- List out positive qualities that you admire in your friend.

2.2. DISEASES AND CAUSES

The word disease means, "without ease or not at ease" and it is opposite to health. The condition of malfunctioning of the organ system or systems is called **disease.** There are numerous diseases that damage our health.

Causes of the diseases

Diseases are caused due to various factors such as pathogens, environmental factors, nutritional factors, genetic factors, metabolic factors, etc.

Based on the causative agent, diseases are classified into:

1. Diseases not caused by organisms
2. Diseases caused by organisms

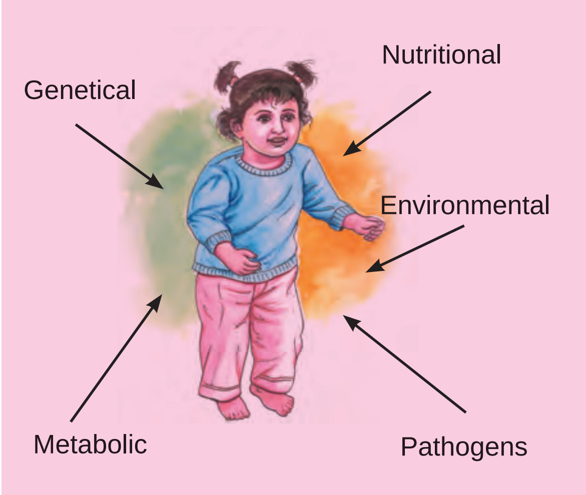


Fig. 2.2 Causes of diseases

Diseases not caused by organisms – Non communicable diseases

1. Organic diseases or Metabolic disorders: Healthy body maintains a constant blood sugar level which is normally 80-120 mg / 100 ml of blood under, fasting conditions. When large quantities of glucose enter the blood stream, as it happens after a meal, the excess glucose is converted into insoluble glycogen and stored in liver and muscles for future use. Later when required, glycogen is reconverted into glucose and reintroduced into blood stream. All these processes are controlled by the hormone, Insulin, secreted by beta cells of Islets of Langerhans of Pancreas. If Insulin is not produced in sufficient quantity, excess of sugar cannot be stored and utilized. As a result, sugar continues to get accumulated in the blood, till it is lost through urine. This leads to other complications and results in diabetes mellitus. Diabetes mellitus is a state of expulsion of excess unused glucose in the urine due to less production of insulin.

Similarly, Diabetes Insipidus, Coronary heart diseases, Renal failure, Hypertension,

Obesity, Alzheimer's disease, Stroke affecting the functions of the brain, etc, are all caused due to metabolic disorders.

2. Hereditary diseases or Genetical disorders: The genetical disorders are caused due to defective or mutated genes. Albinism is an inherited disorder of melanin metabolism, characterized by the absence of melanin in the skin , hairs and eyes. The recessive mutant genes cause this disorder. The clinical symptoms of Albinism are milky white coloured skin and marked photophobia (high sensitivity to light). Haemophilia, sickle cell anaemia, Thalassemia, Down's syndrome, Bubble boy syndrome, etc,. are a few other genetical disorders.

3. Nutritional Deficiency Diseases: A diet which contains all essential nutrients in correct proportion, is indispensable for maintaining good health. Deficiency in certain food constituents, causes various kinds of diseases. Protein deficiency causes Marasmus and Kwashiorkar. In Marasmus, the child loses weight and suffers severe diarrhoea and it will appear as though bones are covered by the skin. In Kwashiorkar the child develops an enlarged belly with swelling in the face and feet.

Fig. 2.3 An albino

4. Diseases caused by Organisms: Robert Koch and Louis Pasteur were the first to establish the Germ theory of diseases. A germ or microbe gains entry into the host, such as man, multiplies so fast that it can increase in large numbers, produce poisonous substance called Toxins and interfere with the host metabolism and produce a characteristic set of symptoms by which the disease can be diagnosed.

Disease producing organism

Fig. 2.4 Kwashiorkar

Fig. 2.5 Marasmus

SOME IMPORTANT VITAMIN DEFICIENCY DISEASES ARE TABULATED BELOW:

Vitamin	Deficiency disease	Symptoms
Vitamin A	Nyctalopia	Night blindness
Vitamin B_1	Beri-Beri	Nervous disorder
Vitamin B_5	Pellagra	Dementia, dermatitis, diarrhoea
Vitamin B_{12}	Pernicious anaemia	Destruction of RBC
Vitamin C	Scurvy	Bleeding gums and loosening of teeth
Vitamin D	Rickets	Defective calcification of bones
Vitamin E	Sterility	Inability to reproduce
Vitamin K	Haemorrhage	Profuse loss of blood

1. Parasitic Micro-organism: The causative organism of a large number of diseases in man, are micro-organisms belonging to different groups. They are viruses, bacteria, fungi and protozoans.

2. Viruses and viral diseases in man: Viruses are living substances inside the host cell and behave as dead particles outside the host cell. The Viral body consists of a nucleic acid, DNA or RNA and a protein cover. All the known viruses are parasitic and some of them cause deadly diseases such as. polio, rabies, hepatitis, meningitis, encephalitis (brain fever), etc.

3. Bacteria and Bacterial Diseases: Bacteria are unicellular prokaryotes and visible under Compound Microscope. Though many bacteria are harmless, some are parasitic and produce diseases. Bacteria can enter the host body through the mouth, nostrils or cuts and bruises on the skin. They multiply rapidly, producing toxins in high concentration to affect health. Some bacterial diseases in man are Tuberculosis, Leprosy, Cholera, Typhoid, Diphtheria, Tetanus, Plague, Pneumonia, Syphilis, Gonorrhoea, etc.

Fungi and Fungal Diseases: Fungi are non green saprophytic or parasitic plants living on dead and decaying organic matter or living organisms. Certain species

of fungi are parasitic on man and cause Ringworm attacking the keratinized layer of skin, destroying it in circular patches.

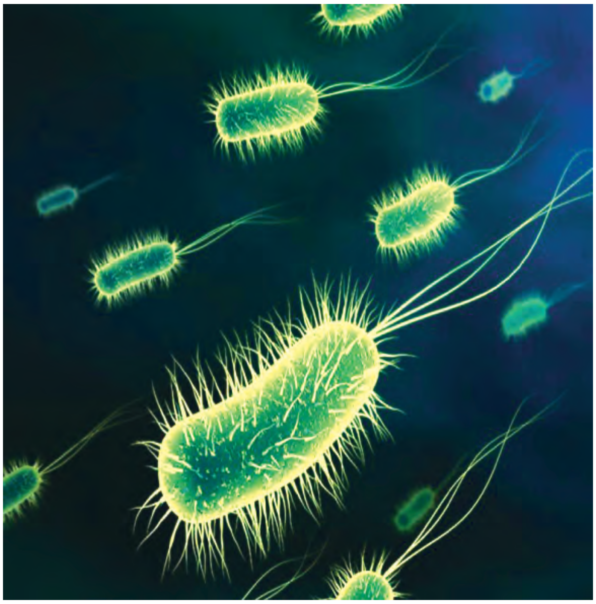


Fig. 2.6 Bacilli

Dandruff, Athletes' foot are some other fungal diseases in man.

Protozoan and Protozoan Diseases: Protozoans are unicellular animalcules, some parasitize man and cause diseases such as malaria, amoebic dysentery, sleeping sickness, etc.

Parasitic macro-organisms: Infestations of the body with tapeworm, liver fluke, round worm, filarial worm, etc,. cause diseases in man like Taeniasis, Ascariasis, Filariasis, etc,.

2.3. DISEASES CAUSED BY MICROBES AND PREVENTION

A disease caused by a parasitic organism and transmitted from one person to another by the transfer of the parasite is known as ***infectious disease***.

We shall study the cause, spread and prevention of a few selected infectious diseases prevalent in our country so that we will know how to guard ourselves against them and other similar diseases.

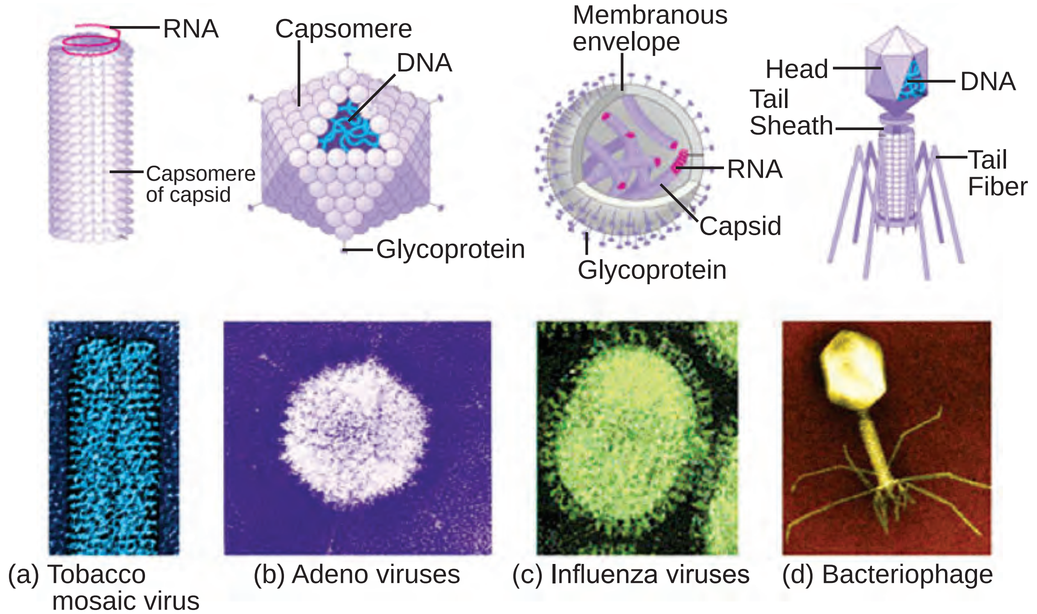


Fig. 2.7 Types of Viruses

2.3.1. Viral diseases

2.3.1.1. Common Cold

More than hundred strains of viruses are responsible, for causing common cold in man. Children are more susceptible to common cold than adults.

Symptoms

1. Inflammation of upper respiratory passage – nasal epithelium.
2. Flow of mucous.
3. Headache, slight rise in temperature, etc,.

It lowers the resistance of the body, leading to a number of secondary infections like pneumonia, bronchitis, etc,.

Transmission

i) It spreads mostly through the droplets discharged from the nose and the mouth of the patient in the process of talking, laughing, sneezing, etc,.

ii) It may also spread through close inanimate objects like handkerchief, bedding, clothes, utensils, toilet articles, etc,. (called ***fomites***)

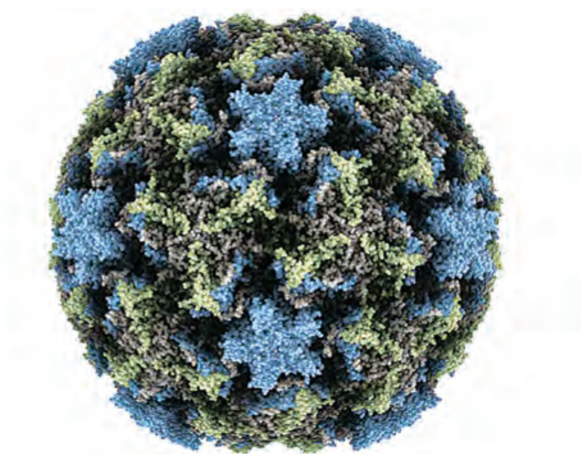


Fig. 2.8 Human rhino virus

Control and prevention: There are no effective measures to control common cold. However, a good nourishing food, avoiding contact with patients and wearing suitable clothing are suggested, to keep away from common cold.

2.3.1.2. Influenza

It was a dreadful disease once and worldwide in distribution (pandemic) in 1970s.

Causative agent : A(H_1N_1) Virus , is spherical in shape and highly contagious, causing influenza.

Fig. 2.9 H1N1 Virus

Symptoms

Sudden onset of fever accompanied by aches and pains in the back and limbs.

Transmission

It spreads through nasal and mouth droplets of patients and enters into the respiratory tract of normal man. It also spreads through fomites.

Prevention

i. Avoid contact with the patients.
ii. Avoid crowding.

2.3.2. Bacterial diseases

Bacteria are prokarotic organisms. Some of the bacteria are parasitic in man, causing diseases like TB, Cholera, Typhoid, dysentry etc.,

2.3.2.1. Tuberculosis

It is an airborne disease affecting the lungs and also parts of our body such as bones, joints, lymph glands, alimentary tract, liver, kidney, etc,.

Causative agent: Mycobacterium tuberculosis, a rod shaped bacterium causes tuberculosis (TB).

Symptoms

i) The affected parts develop lesions in the form of small nodules called tubercles from which the disease gets its name.

ii) Persistant cough

iii) Loss of body weight

Transmission

Tuberculosis is transmitted through air. Large number of bacteria leave the patients through the droplets of sputum expelled by the patients while eating, sneezing, talking, laughing and so on by the patients. The droplets may remain suspended in the air for a long time. The dust arising from the sputum may also contain viable germs. The waxy cell wall of the tuberculosis bacillus prevents it from drying up and so it can remain viable outside the body for a long period. The germs suspended in the air may be inhaled by a healthy person.

Fig. 2.10 Tuberculosis bacteria

Prevention

i) Keeping oneself healthy and avoiding insanitary conditions, overcrowding and poor ventilation.

ii) Sunlight and fresh air are important agents, as they act as natural disinfectants readily destroying the germs.

iii) Isolation of the patients and frequent sterilization of articles used by them are also important.

iv) Incineration (burning) of the droplets, the sputum from the patients to prevent its occurrence in the air.

v) Immunization with BCG vaccine is an effective measure to prevent this disease.

ACTIVITY 2.2

Making a culture of live bacteria

Boil a few grams of chopped meat, carrot and potatoes in water for 15 minutes, then filter off the solid matter to obtain a fairly clear broth.

Leave the broth in open test tubes for a few hours. Plug the tubes with cotton wool and leave them in a warm palce (approximately $25^{o}C$) until the broth has “gone bad” owing to the growth of bacteria.

What you have produced, is a bacteria culture.

BIOLOGY

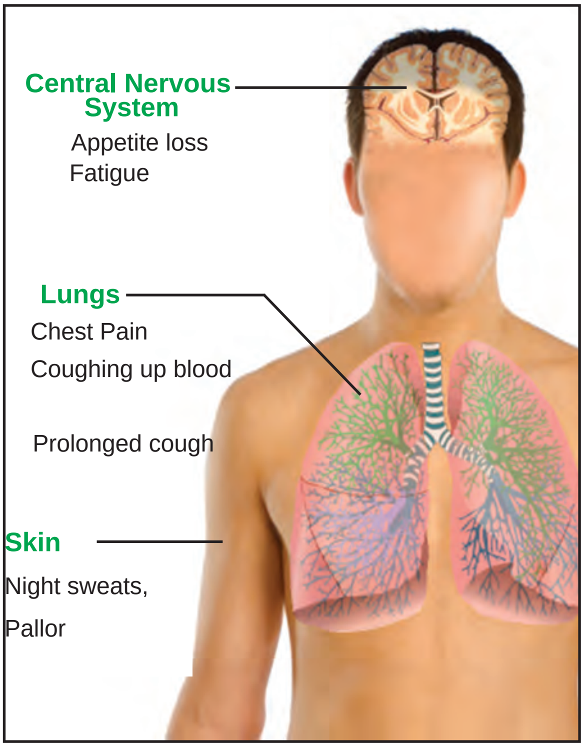


Fig. 2.11 Symptoms of tuberculosis

vi) The patient should cover his mouth and nose while coughing.

2.3.2.2. Typhoid

Causative agent: A short rod shaped bacterium with numerous flagella – ***Salmonella typhi*** causes typhoid.

Symptoms

i) Continuous fever.

ii) Inflammation and ulceration of intestine.

iii) Enlargement of spleen and a characteristic red spot eruption on the abdomen.

Transmission

Transmission of typhoid is through food and water contaminated with the germ, the personal contact with patients and carriers. Flies are also important transmitting agents of this disease.

Prevention and control: Isolation of the patient, control of flies, hygienic food habits, proper public sanitary measures are effective means of prevention of this disease. Artificial immunization with typhoid vaccine is advised. A recovery from typhoid usually confers a permanent immunity.

2.3.3 Protozoan diseases:

Some of the unicellular protozoans are parasitic pathogens and cause diseases in man.

2.3.3.1 Malaria

Causative agent: A tiny protozoan – Plasmodium is responsible for causing malaria. Four different species of Plasmodium namely, P.vivax, P.malariae, P.falciparum and P.ovale occur in India causing malaria. Of these, the malignant and fatal malaria, caused by Plasmodium falciparum is the most serious one.

Transmission

Through the vector - the female ***Anopheles*** mosquito.

Symptoms

i) Malaria is characterized by chillness and rise in temperature. This is followed by perspiration and lowered body temperature. The person feels normal for some time but the fever recurs at regular intervals.

ii) Successive attacks of malaria result in the distension of spleen and destruction of liver tissues.

Prevention and control:

i) Sanitary measures include ground fogging with disinfectants.

ii) Closure of stagnant pools of water and covering ditches is suggested.

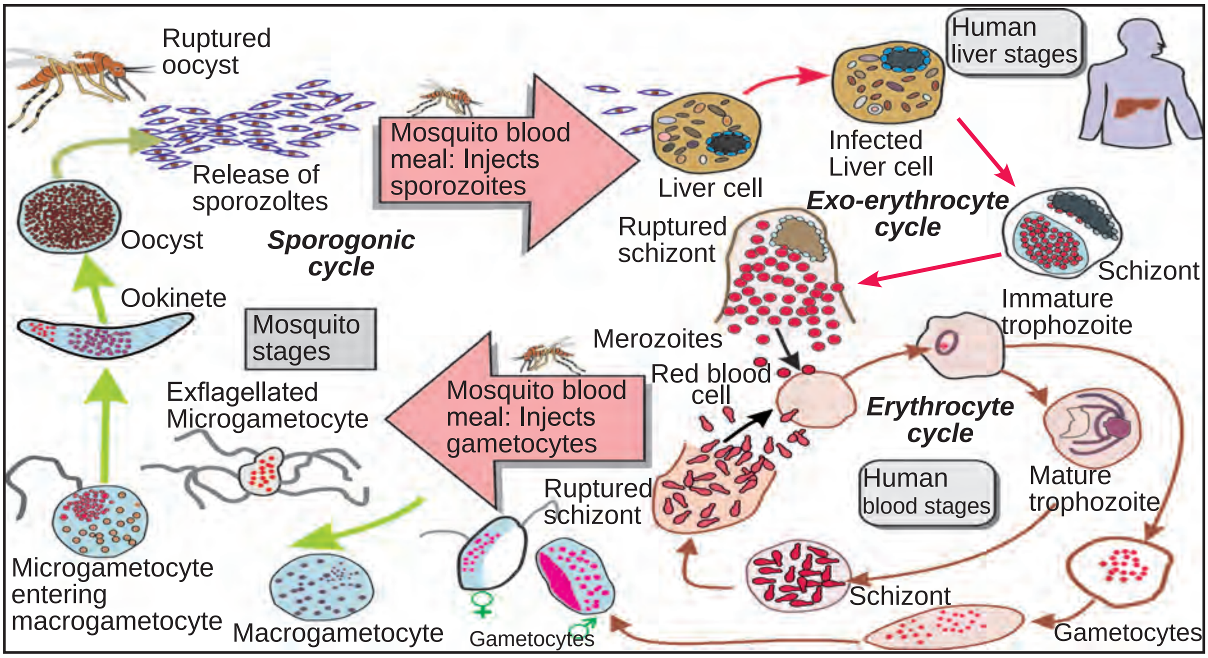


Fig. 2.12 Life cycle of malarial parasite

Life cycle of malarial parasite – Plasmodium: The sexual stage of Plasmodium takes place in female Anopheles mosquito whereas the vegetative stage occurs in man. When a female Anopheles mosquito bites an infected person, these parasites enter the mosquito and undergo further development in the mosquito body. The parasites multiply within the body of the mosquito to form sporozoites that are stored in the salivary glands of mosquito. When these mosquitoes bite a person, the sporozoites (the infectious stage) are introduced into his body; they multiply within the liver cells first and enter the RBC of man, resulting in the rupture of RBC. This results in the release of toxic substance called haemozoin which is responsible for the chill and high fever, recurring three to four days.

Sir. Ronald Ross

Sir. Ronald Ross (1857-1932), a British–Indian physician was born in Almora, India. He had his school education and higher studies in medicine in England. Later he was posted at the Presidency General Hospital, Calcutta. Ross studied about malaria between 1882 and 1899. As he was working in Bangalore, he noticed the connection between water as breeding ground of mosquitoes and the spread of malaria. He discovered the presence of malarial parasites in the female Anopheles mosquito when he was working on malaria at Secunderabad. He demonstrated that malaria is transmitted from infected individual to a healthy person by the bite of mosquito. In 1902, he was awarded the Nobel prize for his work on malaria.

iii) Using mosquito nets and repellants also, will grossly lower the chance for infection.

2.3.3.2. Amoebic dysentry (Amoebiasis)

Causative agent: ***Entamoeba histolytica*** – a protozoan parasite in the large intestine of man causes **Amoebiasis**.

Symptoms

i) Fever.

ii) Constipation and abdominal pain and cramps.

iii) Stools with excess mucous and blood clot.

Transmission

It is a water and food borne disease. House flies act as mechanical carrier and serve to transmit the parasite from the faeces of infected persons to the food – thereby contaminating the food and water.

Fig. 2.13 Clean habits

Prevention and control: Precaution may be taken by providing germ free clean water; clean food habits. Good sanitary facilities will control the flies.

2.3.4. Fungal diseases in man

Some of the fungi are parasitic on man and cause diseases

Fig. 2.14 Ringworm

2.3.4.1. Ringworm

Three different genera of fungi namely, Epidermophyton, Microsporum and Trichophyton cause ringworm.

Symptoms

The above fungi live on the dead cells of outer layer of skin in man and cause superficial infections in skin, hair, nail, etc; and form patches and Itching

Transmission

By direct contact or through fomites such as towels, combs, etc,.

Control and prevention: Avoid contact with infected person and articles used by them.

2.4. MODES OF TRANSMISSION

OF INFECTIOUS GERMS

The transfer of a disease causing germ from an infected person to a normal healthy person through certain agents or direct contact is called transmission of the disease. The transmission can take place in one of the following ways;

Direct Transmission : By direct transfer of germs from the patient to normal healthy person through close contact, the diseases like diphtheria, pneumonia, cholera, typhoid, measles, mumps, etc,. are transmitted.

During sneezing, coughing and talking, the droplets from the patients are discharged from the mouth and the nose and enter the air. While a normal person is inhaling such air, laden with the droplets, he gets infected.

Fig. 2.15 Cover face while caughing and sneezing

Through the umblical cord, the germs are transferred from the infected mother to the child at the time of childbirth by the direct contact method.

Indirect transmission through fomites: Some germs may remain viable outside the body of the hosts and may be transferred indirectly through close inanimate objects used by the patients like clothing, bedding, handkerchief, toilet articles, utensils, drinking cups and glasses that are freshly soiled with the germs present in the discharges of the patients. Such contaminated objects are called **fomites**.

Transmission by animals: Various animals such as ticks, mites, birds, insects and mammals transmit diseases like cholera, malaria, rabies, etc;

2.5. IMMUNIZATION

Immunity: Immunity is part of a complex system of defence reaction in the body. It means the defence against or specific resistance exhibited towards the infectious organisms and their products.

The infectious organisms that invade the body and the toxins produced by them and any foreign protein entering the body are called **antigens**.

The immune system which includes blood plasma, lymph and lymphocytes analyze the chemical nature of the antigens and produce the suitable proteinaceous substances called **antibodies** to detoxify the antigens.

2.5.1. Types of Immunity

Natural or Innate Immunity: The **natural or innate immunity** that enables an individual to resist the disease, to which the particular species is immuned. E.g. Plant diseases do not affect animals.

Acquired or Specific Immunity: The resistance against some infectious diseases developed by an individual during lifetime on exposure to the infections is called **acquired or specific** immunity.

The acquired or specific immunity is of two kinds – active acquired immunity and passive acquired immunity.

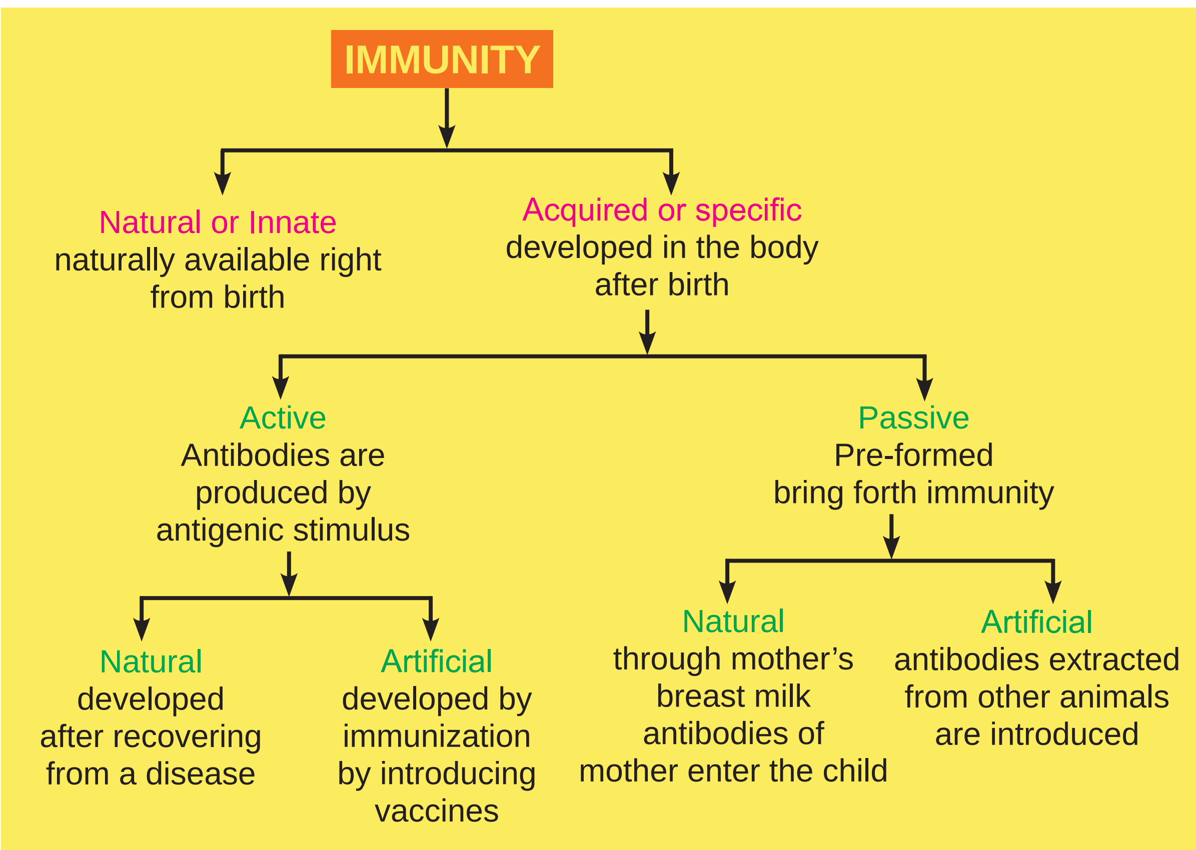
Active acquired immunity: This kind of immunity is developed by our body, during the first infection of any pathogen. The antibodies produced in the blood stays for a long period and kills the similar pathogens whenever they enter the body.

If the antibody production is stimulated naturally, after recovery from a disease, it is called Natural Active Acquired Immunity.

If the antibody synthesis is stimulated by application of vaccines or any other man made methods, the immunity gained is called Artificial Active Acquired Immunity. E.g. The polio drops and triple antigen injected into the child in the immunisation programme.

Passive Acquired Immunity: In this type of immunity, a readymade antibody is introduced from outside instead of

TYPES OF IMMUNITY



stimulating the body to produce antibody with antigenic stimulus.

If the readymade antibody is taken from the mother's blood into the foetus, it is called Natural Passive Acquired Immunity. If the readymade antibody is given to an individual artificially, (produced in some other animal and extracted) it is called Artificial Passive Acquired

MORE TO KNOW

What kind of Immunity does a child get when it is breast fed ?**BREAST FEED IS THE BEST FOOD.** Antibodies or Immunoglobins are found in breast milk. Through breast milk antibodies are passed on to the nursing baby. Bottle fed infants do not have the advantage of fighting the ingested pathogens on their own until the antibodies are produced in them. An infant should be breast fed for a minimum of six months.

Medical establishment knows that infants who are breastfed contract fewer infections than bottle fed infants. Breast milk protects the child, against bacteria like Escherichia coli, Salmonella, Shigella, Streptococci, Staphylococci, Pneumococci and viruses like Polioviruses and Rotaviruses.

IMMUNIZATION SCHEDULE

The immunization schedule indicates the stages at which the vaccinations and inoculations have to be given to safeguard children against different diseases. The table given below lists the names of vaccines, their dosages and the stage at which they have to be administered.

Immunization schedule followed in India

S.No	Age	Vaccine	Dosage
1	New born	BCG	Ist dose
2	15 days	Oral polio	1st dose
3	6th week	DPT & Polio	1st dose
4	10th week	DPT & Polio	2nd dose
5	14th week	DPT & Polio	3rd dose
6	9-12 months	Measles	1st dose
7	18-24 months	DPT & Polio	1st booster
8	15 months - 2 years	MMR vaccine	1st dose
9	2 – 3 years	Typhoid vaccine	2 doses at 1 month gap
10	4 – 6 years	DT & Polio	2nd booster
11	10th year	TT & Typhoid	1st dose
12	16th year	TT & Typhoid	2nd booster

Fig. 2.16 Oral Polio immunization

Immunity. This immunity is not permanent.

Immunization: Administering vaccines to prevent the disease is called immunization. This process of Immunisation develops Artificial Active Acquired Immunity.

Immunisation through inoculation is a mass means of protecting a greater number of people against the spread of diseases.

BCG Tuberculosis Vaccine

DPT Diphtheria, Pertussis, Tetanus Vaccine (Triple antigen)

MMR Mumps , Measles, Rubella

DT Diphtheria, Tetanus (Dual antigen)

TT Tetanus toxoid

2.6. TREATMENT AND PREVENTION OF THE DISEASES

Treatment means medical management of the symptom of the disease.

Medical management includes:

i) Treatment involving medicine.

ii) reatment not involving medicine.

Treatment involving medicine: Medicines are generally used to treat infectious diseases. These medicines either reduce the effect of the disease or kill the cause of the disease.The antibiotics are used as blocks to the pathways of the disease without affecting ourselves.

Treatment not involving medicine: As a person is recovering from the effect of fracture or neurotic problem, yoga and physiotherapy do a great deal of help to do normal activities. People addicted to

Fig. 2.17 Yoga practice

alcohol and drugs are given counselling to overcome the habit.

Prevention: Getting rid of a disease causing germs,is a means of prevention of the disease.

Prevention can be achieved in two ways:

i. General – preventing the infectious germs by keeping away from the exposure to the germs. Hygienic life style, avoiding overcrowding, fresh air, safe drinking water and good sanitary measures are all ways to prevent a disease causing germ, coming into contact with us.

ii. Specific – This relates to a peculiar property of the immune system that usually fights the microbial infections. e.g. Immunisation programme.

2.7. BIO-TECHNOLOGY IN MEDICINE

A detailed account of the role of Biotechnology in healthcare, has been dealt with in chapter 1.

Biotechnologically synthesized insulin has been effectively used replacing the defective insulin to treat diabetes mellitus in the field of medicine.

2.8. HIV AND PREVENTION

Acquired Immune Deficiency Syndrome (AIDS) is a dreadful disease transmitted through sexual contact or through blood and blood products. Robert Gallo at National Institute of Health, USA and Luc Montagnier at Pasteur Institute, Paris isolated the virus, Human Immuno Deficiency Virus (HIV) which causes AIDS.

HIV is a retro virus with glycoprotein envelope and the genetic material – RNA. HIV causes profound Immuno suppression in humans. It is due to the depletion of one type of WBC, which is involved in the formation of antibodies called CD4 plus T-helper cells (lymphocytes).

Symptoms: Significant weight loss, chronic diarrhoea, prolonged fever, opportunistic infections such as tuberculosis, candidiasis and recurrent herpes zoster (viral) infection.

Test for Virus:

1. Enzyme Linked Immuno Sorbent Assay (ELISA)
2. Western Blot – a confirmatory test.

Prevention:

1. Protected sexual behaviour.
2. Safe sex practices.
3. Screening the blood for HIV before blood transfusion.
4. Usage of disposable syringes in the hospitals.
5. Not sharing the razors / blades in the saloon.
6. Avoid tattooing using common needle.

EVALUATION

PART A

1. Pick out a case of healthy state of an individual.

   Mr. X is recovering from an infectious disease,

   Mr. Y is taking insulin injection everyday,

   Mrs. Z is very much depressed,

   Mr. K is attending to his duty and spends time joyfully,

2. Which one of the following is a state of a disease in which a person is not socially balanced.

   He enjoys a birthday party,

   He behaves rudely even for menial matters,

   He is adjusting to the surrounding situation,

   He is attending to his ailing mother at the hospital.

3. Pick out the bacterial disease.
   Meningitis,Rabies,Tetanus, Small pox.
4. One of the following is transmitted through air. Find out.

   Tuberculosis, Meningitis,Typhoid, Cholera.
5. The most serious form of malaria is caused by Plasmodium ________.

   P.ovale, P.malariae, P.falciparum, P.vivax.
6. An example for protozoan infecting our intestine is _______________.

   Plasmodium vivax, Entamoeba histolytica,Trypanosoma gambiense, Taenia solium.
7. One of the means of indirect transmission of a disease is _____.

   Sneezing,Droplet from mouth,

   Placenta,Utensils of patients.
8. When antibodies, extracted from some other animal is injected into your body, what kind of immunity do you gain?

   Artificial active acquired immunity,

   Artificial passive acquired immunity,

   Natural active acquired immunity,

   Natural passive acquired immunity.
9. The first vaccine injected into a just born baby is ___________.

   Oral polio, DPT,

   DPT and Oral polio,BCG.
10. Pick out a non-antigen. Entry of ____________.

    (Germ,Toxins of germs,New forms of protein, Mother's Milk.

PART B

11. In order to lead a healthy life a person should enjoy physical, mental and social well being If a person lacks any one of them, then that person is suffering from _________.
12. Tamil selvan has inherited colour blindness from his father. Name the causative factor responsible for this defect _______.
13. Marasmus and Kwashiorkar are both protein deficiency defects. Marasmus differs from Kwashiorkar in enlarged belly and swelling in the face. Are these symptoms for the above diseases correct? If not, correct it.
14. A list of disorders are given below. Pick out the odd one out and give reasons. (colour blindness, haemophilia, night blindness, albinism, sickle cell anaemia)
15. Ramya is suffering from bleeding gum and loosening teeth. On a diagnosis, it was found to have been caused by vitamin deficiency.

    Suggest Ramya the kind of vitamin that is lacking in her food and tell your friend the name of deficiency disease that she suffers from.

    (A) Vitamins

    (B) Deficiency diseases and

    (C) Symptoms are given.

Match B, C with A.

A	B	C
Vitamins	**Deficiency diseases**	**Symptoms**
e.g. Vitamin A	Nyctalopia	Night Blindness
Vitamin B1	Scurvy	Nerbvous disorder
Vitamin C	Rickets	Bleeding Gum
Vitamin D	Haemorrhage	Defective calcification of bones
Vitamin K	Beri-beri	Profuse loss of blood

16. Kavitha is suffering from common cold. What are the questions you will put forth to Kavitha to confirm the disease?

    a. ____________________

    b. ____________________

PART C

17. Kala has delivered a baby,

    a. Suggest the immunization schedule for the baby, in the first six months

    b. What are all the diseases that can be cured as per the schedule?

18. There is a widespread outbreak of malaria in your area.

    a. Suggest some controlling measures to the local authorities concerned.

    b. Pick out the right symptom for malaria. (chill and shiver and a rise in temperature / diarrhoea)

19. 15th October is observed as 'Handwashing Day'

    a. Tell your friend the effects of hand washing.

    b. In a day what are the occasions in which you wash your hand?

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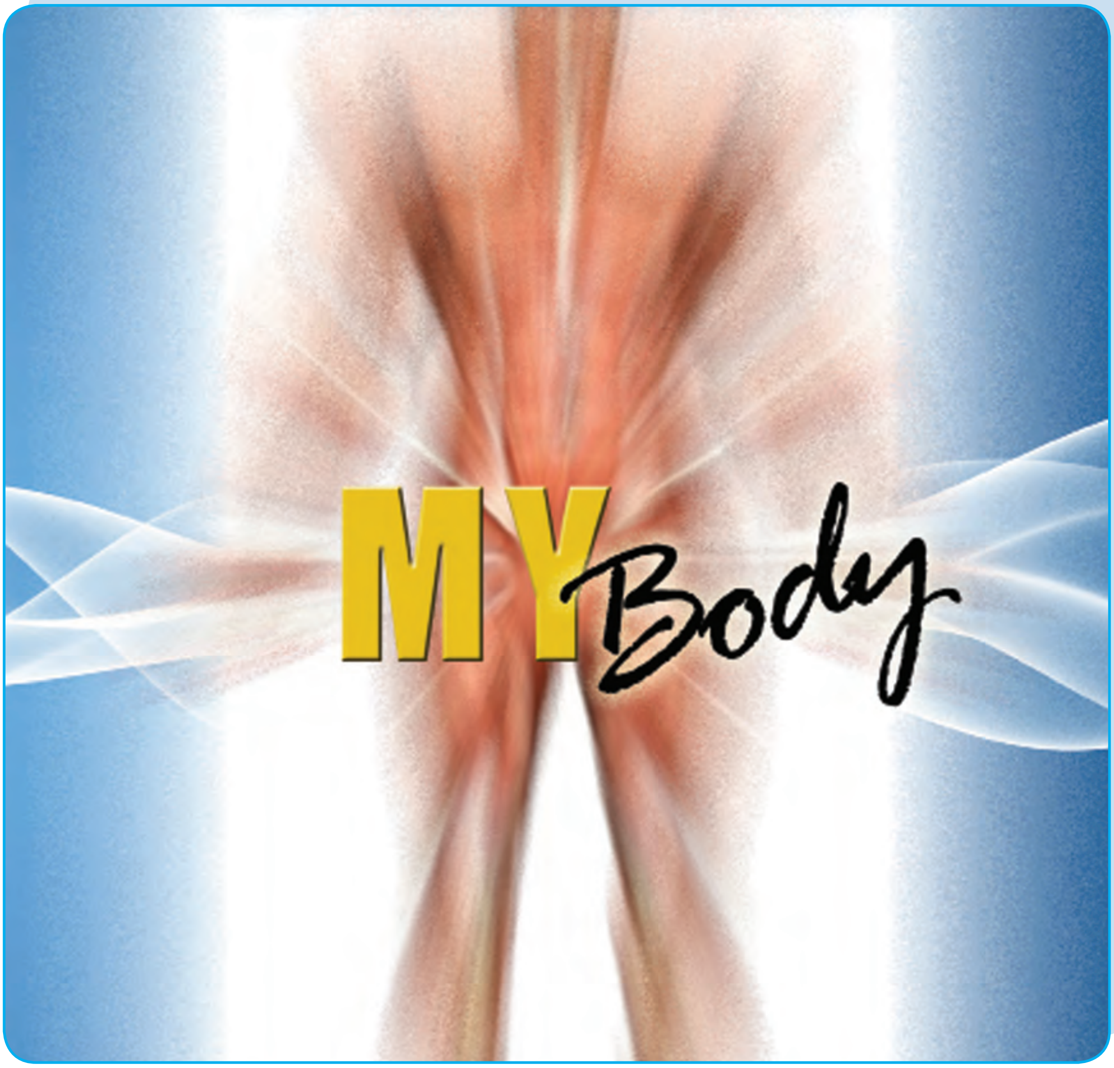
2. Biology - A Modern Introduction, B.S. Beckett, Second Edition Oxform University Press.

Chapter 3



STRUCTURE AND FUNCTIONS OF HUMAN BODY-ORGAN SYSTEMS

3. STRUCTURE AND FUNCTIONS OF HUMAN BODY-ORGAN SYSTEMS

NERVOUS SYSTEM – INTRODUCTION

Two or more people when gather together, each one is set with an interest and aptitude and performs his works in his own way. But when it is the question of maintenance of an order, a systematic working among them, there is a need for someone to control and co-ordinate them so that a harmony prevails. Similarly the functions of organs and organ system is our body cannot go on in their own way but must be coordinated to maintain the harmonius steady state of body functioning called Homeostasis. Coordination is the process through which two or more organs interact and compliment the functions of one or the other. In our body the neural or nervous system and the endocrine system do the function of coordinating and integrating all the activities of the organs so that the body works efficiently by synchronizing the functions.

The nervous system provides an organized network of point to point connections for a quicker coordination. The endocrine system provides chemical integration through hormones. In this chapter, we will learn the structure and functioning of the nervous system and the endocrine system in man.

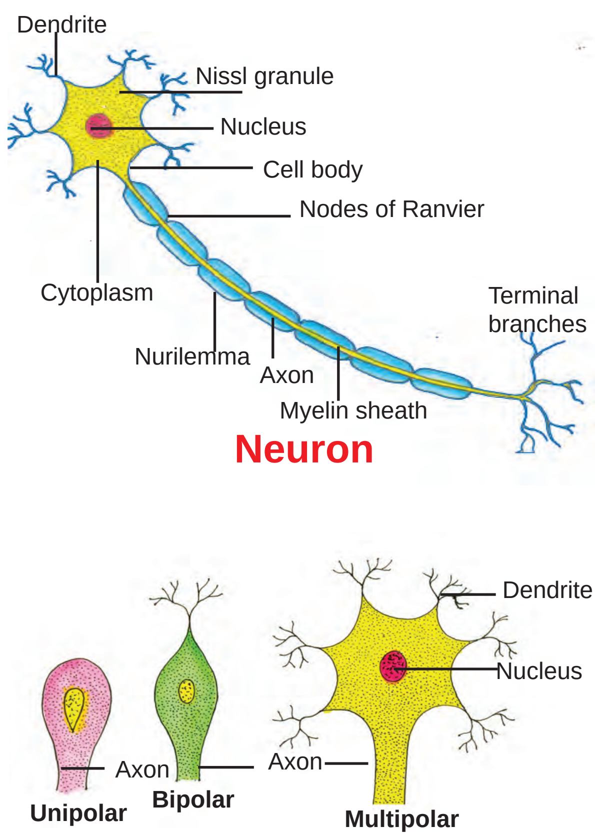


Fig. 3.1 structure of neuron and types

3.1 NERVOUS SYSTEM

The nervous system of an animal is composed of

i) Specialized cells called neurons or nerve cells which can detect, receive and transmit different kinds of stimuli.

ii) The nerve fibres which are certain bundles of extended processes of nerve cells.

3.1.1 Nerve cells

Nerve cells or neurons are the structural and functional units of the nervous system.

Billions of nerve cells make up our brain. A nerve cell is a microscopic structure consisting of three major parts namely cell body, dendrites and axon.

Cell body

It is the cell structure irregular in shape or polyhedral structure, it is also called as cyton. Cell body contains cytoplasm with typical cell organelles and certain granular bodies are called Nissl granules .

Dendrites

Dendrites or Dendrons are shorter fibres which branch repeatedly and project out of the cell body. Dendrites transmit electrical impulses towards the cyton.

Axon

One of the fibres arising from the cell body is very long with a branched distal end and it is called as Axon.

The distal branches terminate as bulb like structures called synaptic knob filled with chemicals called neuro transmitters. Axon contains axoplasm inside and is covered by a membrane called neurilemma. Neurilemma encloses the axon except at the branched distal ends. In some neurons called myelinated neurons an additional white fatty fibre called myelin sheath covers the neurilemma. Myelin sheath is not continous over the neurilemma. The gaps left by the myelin sheath on the axon are called Nodes of Ranvier. Over the myelin sheath are found certain cells called Schwann cells.

Types of nerve cells

a) Myelinated or Medullated or White neurons:

When the axon is enclosed by the white fatty myelin cover it is called Myelinated or Medullated or White neurons. This forms the cerebral cortex of our brain.

b) Non- Myelinated or Non-Medullated or Grey neurons:

This neuron is not enclosed by myelin sheath; so it appears greyish in colour. The axon is covered by only neurilemma and Schwann cells. This type of neuron is found in the white matter of cerebrum.

c) Unipolar neurons:

The embryonic nervous tissue contains unipolar neurons. An unipolar neuron has a nerve cell body with a single process or fibre, which will act both as axon and Dendron.

d) Bipolar neurons:

The sensory hair cells of the sense organs like rods and cones of retina are made up of bipolar neurons. Each bipolar neuron has a cell body and two process at the ends, one acting as axon and the other acting as Dendron.

e) Multipolar neuron:

The cerebral cortex contains the multipolar neurons; each multipolar neuron has a cell body with many dendrites and an axon.

Synapse: The dendrites and the synaptic knobs of the axons of neighbouring neurons are in physical contact with one another without fusing. This point of contact between the neighbouring nerve cells is called synapse.

ACTIVITY 3.1

Visit a hospital in your locality and study the principle behind the administration of anesthesia at the time of surgery. Find out if the fat soluble anesthetic substances like chloroform, ether etc,. merge with medullary sheath and prevent conduction of nerve impulse.

3.1.2 Nerve impulse:

The conduction of stimuli by the nerve cells is called nerve impulse. The dendrites will receive the stimuli from the receptor (sense organ) and conduct the same as electrical impulse to the axon through the cyton. At the synapse, the synaptic knobs release out chemical substances called neuro transmitters which convert the electrical impulse into chemical impulse and pass it to the neighbouring neuron.

3.1.3 Human nervous system

The human nervous system is divided into

a) The Central Nervous System (CNS) and

b) The Peripheral Nervous System (PNS)

c) The Autonomic Nervous System (ANS)

The CNS includes the brain and spinal cord and it is the site of information processing and control.

The PNS comprises of the nerves of the body associated with the central nervous system.

3.1.3.1 Central Nervous System

It is organized of two organs namely the brain and the spinal cord. The CNS is accommodated in the protective bony structures namely skull and vertebral column.

MENINGES: The central nervous system is covered by three protective coverings or envelops collectively called meninges. The outermost cover lying below the skull and vertebral column is doubly thick and is called ***Duramater***. The middle covering is thin and vascularised and is called ***Arachnoid membrane***. The innermost cover is a very thin delicate membrane and is closely applied on the outer surface of brain and spinal cord and it is called ***Piamater***.

3.1.3.1.1 The Brain

Man is a vertebrate and a mammal belonging to the animal kingdom. But, he stands unique and supreme and this supremacy in the living world is reflected in the organization of the brain. The brain is the central information processing organ and acts as the command and control system.

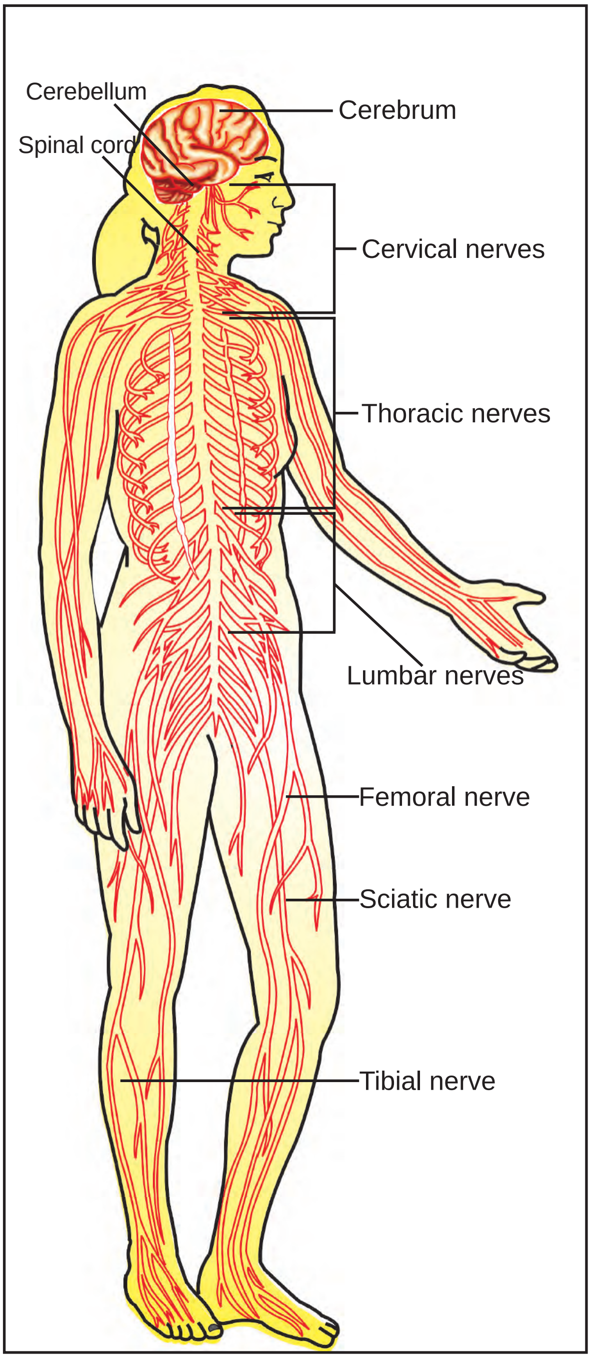


Fig. 3.2 Human Nervous System

The human brain as in the case of other vertebrates, is divided into three major parts:

a) Fore brain b) Mid brain
c) Hind brain

Fore brain

Fore brain consists of cerebrum, thalamus and hypothalamus.

Cerebrum

This forms the major part of the human brain (nearly two third of the brain is cerebrum). A deep cleft called **median cleft** divides the cerebrum longitudinally into two halves as right and left cerebral hemispheres, which are united at the base by a sheet of nervous tissue called **corpus callosum,** The outer region of the cerebrum is distinguished as, the grey matter or cerebral cortex and the inner region is called white matter.

Cerebral cortex

It consists of the nerve cell bodies of several layers of greyish nerve cells giving grey colour – so called as grey matter. The increased surface area of the cerebral cortex in man is folded and thrown into a pattern of convolutions consisting of ridges and furrows.

Cerebral cortex contains

a) motor areas
b) sensory areas and
c) association areas (a region that is neither sensory nor motor).

Motor areas

Motor areas are the sites of order or command of the cerebrum, from where the order arises to control the activities of the different organs of our body. Initiation of voluntary activities takes place here.

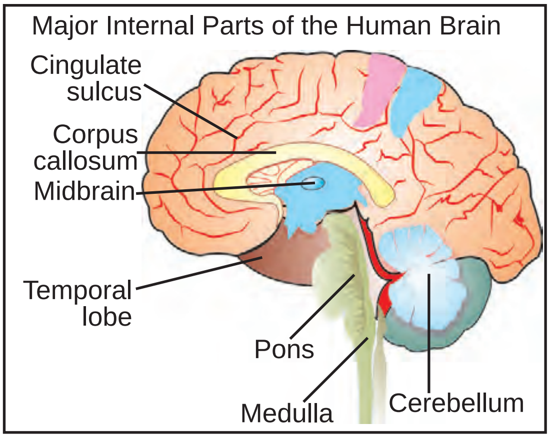


Fig. 3.3 Major internal parts of human brain.

Sensory areas

These are the sites where the sensory functions of the various sense organs are received through the sensory nerves.

Association areas

These are responsible for complex functions like intersensory associations, memory and communication.

White matter of cerebrum: The inner part of the cerebrum lying below the cerebral cortex is called white matter and it consists of bundles of nerve fibres with myelin sheath giving the white colour. Some of these bundles of nerve fibres connect the different parts of the cerebrum while others connect the cerebrum with the rest of the brain and spinal cord.

Within the cerebral hemispheres are present cavities called ventricles, filled with a nutritive fluid called cerebro spinal fluid.

Functions of cerebrum: Cerebrum is the seat of consciousness, intelligence, memory, imagination and reasoning. It receives impulses from different parts of the body and initiates voluntary activities. Specific areas of cerebrum are associated with specific functions. Thus there is a centre for hearing, another for seeing, another for tasting, another for smelling, another for speaking and so on. A damage in a specific centre of cerebrum will deprive the particular faculty from doing its functions.

Thalamus

Cerebrum wraps around a structure called thalamus – a major conducting centre for sensory and motor signalling.

Hypothalamus

It lies at the base of the thalamus. It controls body temperature, urge to

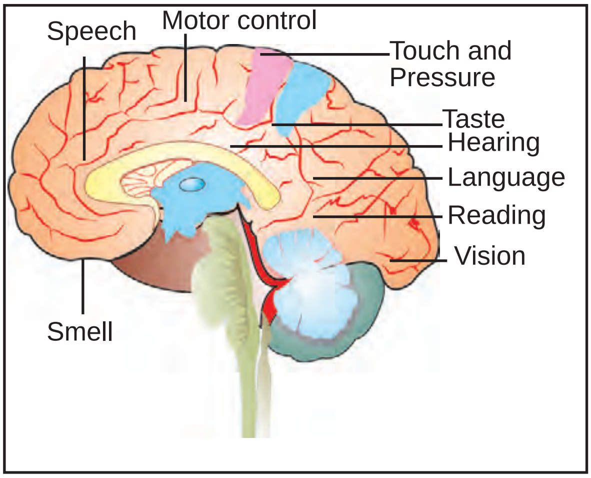


Fig. 3.4 Functional areas of human brain.

BIOLOGY

eat and drink, regulation of sexual behaviour, express emotional reactions like excitement, anger, fear, pleasure and motivation.

Mid brain

The mid brain is located between the thalamus and the hind brain. A canal called **cerebral aqueduct** passes through the mid brain. The dorsal portion of the mid brain consists of four hemispherical bodies called **corpora quadrigemina** which controls and regulates the various visual reflexes and optical orientation.

Mid brain with hind brain together form the brain stem.

Hind brain

Hind brain comprises of pons, cerebellum and medulla oblongata.

Cerebellum

It lies below the cerebrum and consists of a median portion and two lateral lobes. Cerebellum regulates and coordinates the group movements of voluntary muscles as in walking or running.

Pons

It is the bridge of nerve fibres that connects the lobes of cerebellum. It relays the information from the cerebrum to cerebellum. It also contains sleep centre and respiratory centre.

Medulla oblongata

Medulla is the posterior most part of the brain where it merges with the spinal cord. It acts as a coordination pathway for both ascending and descending nerve tracts. Medulla is the centre for several reflexes involved in the regulation of heartbeat, blood vessel contraction, breathing, etc,.

The ventricle of the medulla remains connected with the ventricles of the cerebral hemisphere.

3.1.3.1.2 The Spinal cord

This is a tubular structure, a continuation of the brain lying in the neural canal of the vertebral column. The three meninges – Piamater, Arachnoid membrane and the Duramater cover the spinal cord as in the case of brain.

The spinal cord has two enlargements – one in the neck region of the body called **cervical plexus** and another in the lumbar region of the vertebral column called ***lumbar plexus***.

The spinal nerves arise from these enlargements. The lower end of the spinal cord is filamentous and is called ***Filum terminale***. On the mid dorsal side of the spinal cord is found a narrow depression called ***dorsal fissure*** and on the mid ventral side of the spinal cord is found a deep depression called ***ventral fissure***. Running through the center of the spinal cord is the ***central canal***, an extension of the ventricle filled with **cerebro spinal fluid**. Outer region of the spinal cord contains medullated white neurons and the inner region contains non-medullated grey neurons. The spinal cord conducts impulses to and from the brain and acts as a reflex centre.

3.1.3.2 Peripheral nervous system (PNS)

The nerves arising from the brain and spinal cord constitute the PNS.

a) Cranial nerves:

Twelve pairs of cranial nerves arise from the brain. Some of the cranial nerves are sensory nerves (taking impulse from the sense organ to the brain e.g., optic nerves from the eyes). Some of the cranial nerves are the motor nerves taking impulse from the brain to the effector organ. e.g. vagus nerve innervating the heart and some are mixed nerves with both sensory and motor functions. e.g facial nerve

b) Spinal nerves:

Thirty one pairs of spinal nerves arise from the spinal cord. Each spinal nerve has a sensory root and a motor root. Thus, all spinal nerves are mixed nerves.

3.1.3.3 The Autonomic Nervous System (ANS)

It controls the functions of the vital organs of the body through its two antagonistic divisions namely, sympathetic nerves and parasympathetic nerves.

3.2. ENDOCRINE SYSTEM IN MAN

The chemical coordination of physiological processes to maintain the homeostasis is the work of endocrine system. Endocrines control and coordinate the physical processes of growth, reproduction and sustenance of life.

Endocrine system consists of a number of endocrine glands and their hormones.

Endocrine glands are ductless glands (without ducts), secreting the chemical substances called hormones. The hormones are carried by the blood from the site of production to the site of action.

Endocrine glands in man are distributed in the different regions of the body without interconnections. The various endocrine glands found in different regions in man are as follows:

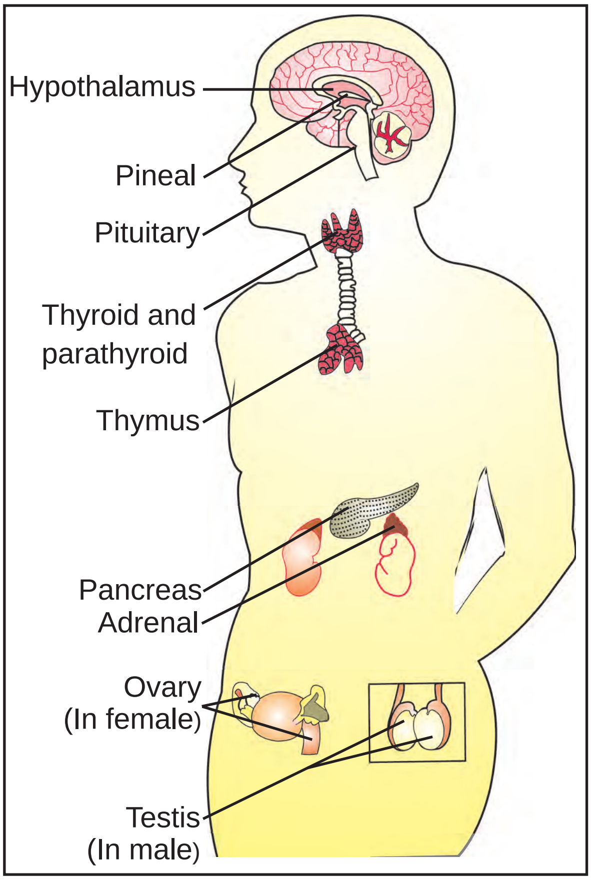


Fig. 3.5 Endocrine system in man

Head	–	a) pituitary gland
		b) pineal gland
Neck	–	a) thyroid gland
		b) parathyroid gland
Thorax	–	thymus gland
Abdomen	–	a) pancreas – Islets of Langerhans

b) adrenal glands – adrenal cortex and adrenal medulla

c) gonads – testes in man and ovaries in woman

Hormones

Chemically hormones are proteins or amino acids or steroids. Though the hormones are secreted in small quantities, their performance is profound in action.

Pituitary gland

It is a tiny gland of the size of a pea attached to the hypothalamus of the brain. Since some of the endocrine glands are regulated by the pituitary gland, it is called as the conductor of endocrine orchestra.

Divisions of pituitary : Pituitary gland is differentiated into an anterior lobe called ***adenohypophysis*** and a posterior lobe called ***neurohypophysis***.

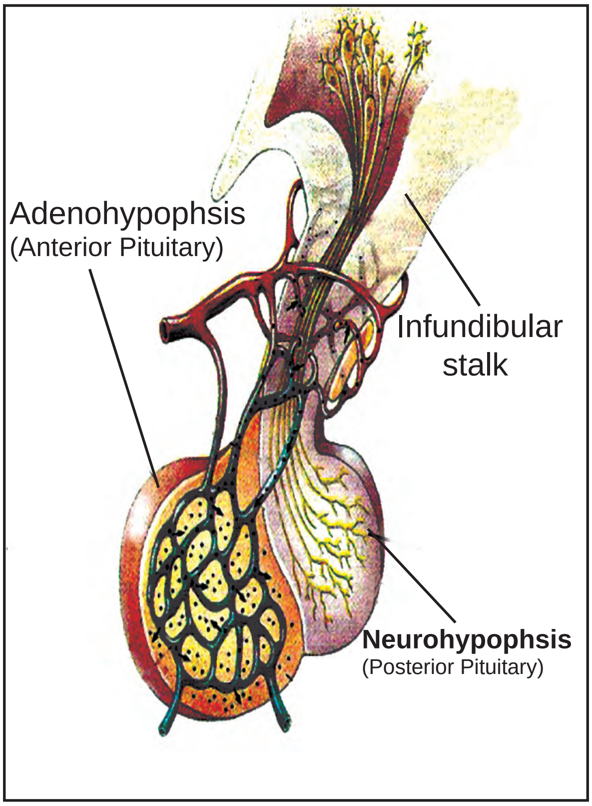


Fig. 3.6 Diagrammatic internal view of pituitary gland

Hormones of adenohypophysis	Functions and malfunctions
Somatotropic or Growth hormone (STH or GH)	• It brings forth growth in general • Less production in children – ***dwarfism*** with retarded growth • Excess production in children – ***gigantism*** with excess growth • Excess production in adolescents – ***acromegaly*** with large limbs and lower jaw
Thyrotropic or Thyroid stimulating hormone (TSH)	It stimulates the growth of thyroid gland and its production – the thyroxine
Adrenocorticotropic or Adrenal cortex stimulating hormone (ACTH)	It stimulates the adrenalcortex to produce the hormones aldosterone and cortisone

Follicle stimulating hormone (FSH)	It stimulates the maturation of graafian follicles (in the ovary) in the female, to produce the eggs and sperm formation in the males.
Lutenizing hormone (LH) in female or interstitial cell stimulating hormone (ICSH) in male	LH in female causes discharge of egg from graafian follicle – a process, called ovulation and production of female sex hormone oestrogen and progesterone. ICSH in male, induces the interstitial cells to produce male sex hormone – testosterone
Lactogenic hormone (LTH)	It stimulates the growth of mammary glands in female and milk production after child birth.

"The hormones of neuro hypophysis namely, oxytocin and vasopressin are secreted by hypothalamus and are released on specific stimuli. Thus the neurohypophysis hormones are secretions of a part of the nervous system and are chemically octapetides and decapetides"

Hormones of Neuro hypophysis	Functions and malfunctions
Oxytocin	It speeds up the child birth process, by stimulating the contraction and relaxation of the uterus in the female.
Vasopressin or Antidiuretic hormone (ADH)	It helps in the reabsorption of water, producing concentrated urine in small quantity. It constricts the blood vessels and raises up the blood pressure Less production of ADH results in ***diabetes insipidus***, leading to production of excess of dilute urine.

Thyroid gland

The bilobed thyroid gland is located in the neck, one lobe on each side of larynx, which secretes a hormone called ***thyroxine***. Thyroxine is an iodinated protein, composed of the amino acid, tyrosine and iodine.

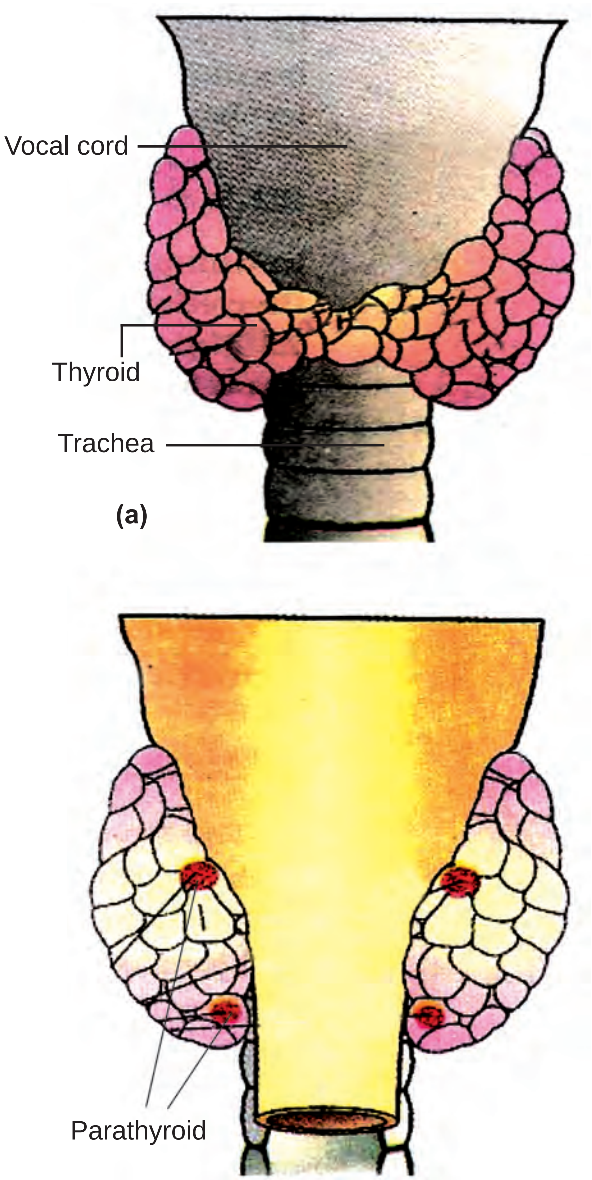


Fig. 3.7 Thyroid gland a) Dorsal view b) Ventral view

Functions of thyroxine

- It increases the rate of metabolism.
- It stimulates a rise in the body temperature.
- It promotes growth and differentiation of tissues.
- Since it affects indirectly growth of the body, thyroxine is also called as **personality hormone**.
- it regulates iodine and sugar level in the blood.
- it controls working of kidneys and urine output.

Thyroid disorders

1) Hypothyroidism – less secretion of thyroxine causes many abnormalities. like ***simple goitre***, ***myxoedema*** and ***cretinism.***

   a) Simple goiter – It is due to the deficiency of iodine in our diet. Thyroid gland bulges as a swelling in the neck and it is called as ***goiter***.

   b) Myxoedema – It is caused in the adults, the symptoms are, low

Fig. 3.8 a person with goitre

metabolic rate, loss of mental and physical vigour, increase in weight, thickening of skin, lowered heartbeat, mental dullness, etc,.

c) Cretinism – This is produced in children and the symptoms are stunted growth, retarded mental development, defective teeth, protrusion of tongue and loose skin.

2) Hyperthyroidism – The excess production of thyroxine causes exophthalmic goiter or Grave's disease. The symptoms are high metabolic rate, high blood pressure, high irritability, profuse sweating, loss of weight, fatigueness and protrusion of eyeballs.

The islets of Langerhans

Pancreas is a dual role playing endocrine gland. The exocrine parts produce pancreatic juice. The endocrine portion is called **islets of Langerhans**. It consists of two type of cells namely, alpha cells and beta cells. **Alpha cells** produce a hormone called glucagon and **Beta cells** produce insulin and amylin**.**

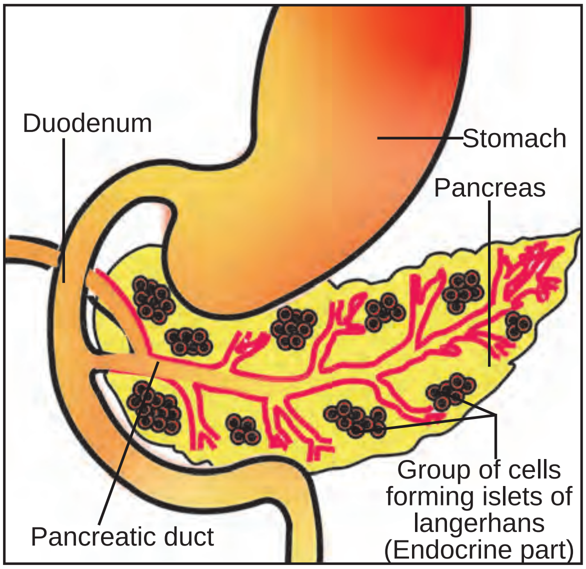


Fig. 3.9 Pancreas showing islets of Langerhans

Insulin

- It promotes the uptake of glucose by the cells for tissue oxidation.
- It favours conversion of glucose, into glycogen and its storage in the liver and the muscles.
- It prevents the formation of glucose from protein and fat.
- It maintains normal blood glucose level at 80 – 120 mg / 100 ml of blood.

Diabetes mellitus

Less production of insulin causes Diabetes mellitus, in which the excess unused glucose is excreted in the urine.

Glucagon

- It is secreted when glucose level in the blood is low.
- It influences conversion of glycogen into glucose, thus raising the blood glucose level.

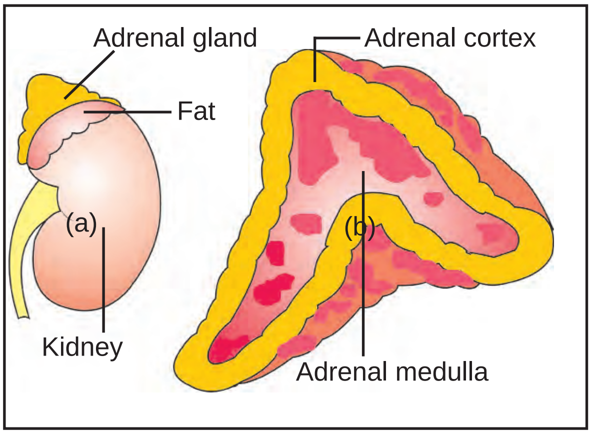


Fig. 3.10 a) Adrenal gland b) LS of Adrenal gland

Adrenal gland (Supra renal gland)

On each kidney is found an adrenal gland. It is composed of two portions, an outer adrenal cortex and an inner adrenal medulla.

Adrenal cortex

It secretes two hormones namely, Aldosterone and Cortisone

Aldosterone (Mineralocorticoid)

It maintains mineral metabolism, by favouring reabsorption of sodium and water and excretion of potassium and phosphate ions.

It maintains electrolyte balance, body fluid volume, osmotic pressure and blood pressure.

Cortisone (glucocorticoid)

It stimulates the breakdown of glycogen into glucose raising the blood glucose, level.

It also produces an anti-inflammatory reaction and suppresses the immune response.

Adrenal medulla

It is made up of modified neuroectodermal cells. It secretes two hormones, namely ***adrenaline (epinephrine)*** and ***noradrenaline (norepinephrine).*** They are together called **emergency hormones or hormones of flight and fight** as they rapidly mobilize the body to face a stress or emergency situation.

- They increase the heartbeat.
- They increase alertness.
- They increase the respiratory rate.
- They promote the conversion of glycogen into glucose.
- They cause dilation of pupil.
- They cause profuse sweating.
- They make the hair stand erect. (gooseflesh)
- In short noradrenaline and adrenaline mobilize the body, to face the emergency by fighting with it or running away from it.

Testes

They are both cytogenic (producing sex cells) and endocrine (producing male sex hormones) in functioning.

The endocrine part secretes male sex hormone called ***testosterones (androgen).***

Testosterone stimulates the growth of reproductive organs and the production of male sex cell, the sperms.

Testosterone determines the secondary sexual characters in male, such as growth of facial hairs, hoarse voice, broadening of shoulder, etc,.

Ovaries

Ovaries are both cytogenic (producing egg cells) and endocrine (producing reproductive hormones, such as oestrogen, progesterone and relaxin) in functioning.

Oestrogen is responsible for growth of female reproductive organs and the appearance of secondary sexual characters in female, such as growth of pubic hairs, soft voice, feminine body, etc.,

Progesterone maintains pregnancy and regulates menstrual cycle.

Relaxin relaxes the muscles of the pelvic region at the time of child birth.

Parathyroid gland

These are found within thyroid and produce the hormones mainly ***parathormone*** and calcitonin which maintain the mineral metabolism.

Thymus gland

It's a lymphoid mass, present above the heart. It secretes ***thymosin*** which stimulates the differentiation of "T"lymphocytes to resist infection.

Pineal gland

It lies under the corpus callosum in the brain. It produces ***melatonin*** ,causing concentration of pigments in some specific areas like areola, scrotal sacs, etc,.

3.3. CELL DIVISION

A matured cell divides into two daughter cells. Unicellular animalcules like amoeba, undergo binary fission – without any change in the chromatin reticulum by a type of cell division called Amitosis.

Body cells of all animals and plants undergo a cell division called ***Mitosis*** ,involving changes in the structure of chromosomes, but without any change in the chromosomal number.

The germinal epithelial cells of animals undergo ***Meiosis*** cell division, involving changes in the structure and number of chromosomes.

You have studied the process of mitosis in the previous year. We will understand the various stages of meiosis and its significance in this unit.

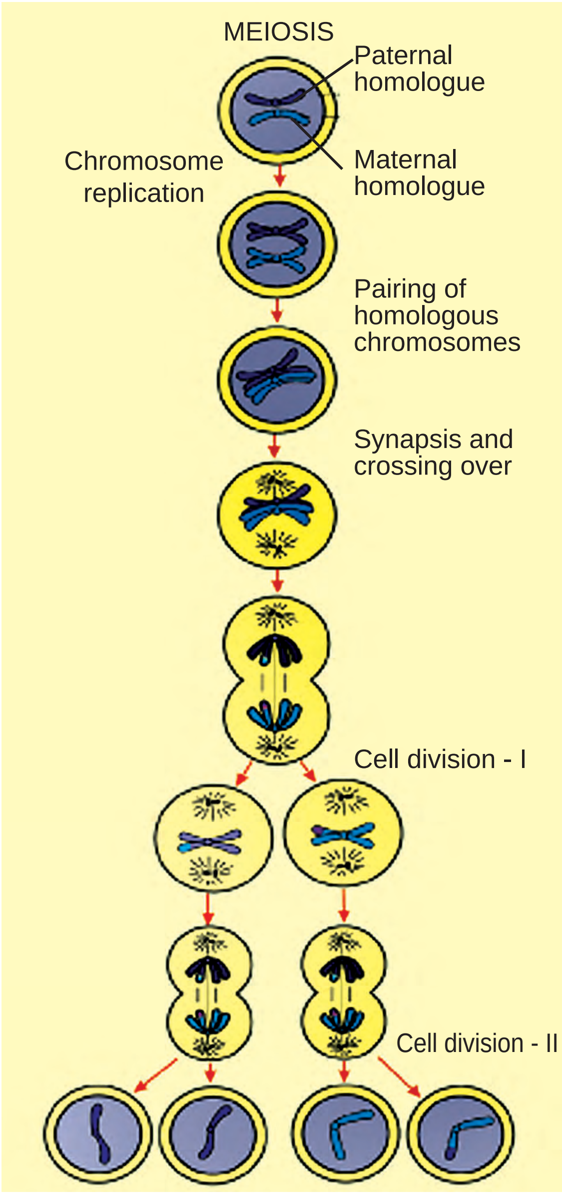


Fig. 3.11 Meiosis - stages

Meiosis

Meiosis is a kind of cell division, which occurs in the germinal epithelial cells of the gonads to form the gametes. Meiosis takes place in the specialized

diploid cells of gonads and produces four haploid gametes, each having half the number of chromosomes as compared to the parent cell. Meiosis is completed in two successive divisions – Meiosis-I and Meiosis-II. In Meiosis-I, as the chromosomal number is reduced to half, it is called Reduction division. Meiosis-II is similar to Mitosis.

Meiosis - I

The various events of Meiosis-I are studied under four substages namely Prophase-I, Metaphase-I, Anaphase-I and Telophase-I.

Prophase - I

The chromatin reticulum unwebs and individual chromosomes are liberated from one another. The nuclear membrane dissolves. The chromosomes undergo, marked differences in their shape and structure. Based on the shape of the chromosomes, this stage is studied under five sub-divisions as Leptotene, Zygotene, Pachytene, Diplotene and Diakinesis.

Leptotene

The chromosomes condense and appear like threads. Each chromosome splits up longitudinally, except at the centromere.

Zygotene

The homologous chromosomes come closer and start **pairing**. (a homologous pair of chromosomes consist of a paternal chromosome and maternal chromosome with similar genes). The pairing starts from the tip or from the middle and get attached laterally throughout the length. This pairing is called **Synapsis**, the paired chromosomes are called **Bivalents.**

Pachytene

The paired chromosomes become shorter and thicker. Each bivalent appears to have four strands called as, ***tetrads*** or ***quadrivalents*****.** The point of contact between the homologous pair of chromosomes are called, ***Chiasmata*****.** At the point of chiasmata, exchange of chromosomal segment takes place, between the chromatids of the homologous pairs. This exchange of segments of chromatids between homologous chromosomes, is called ***crossing over***.

Diplotene

After the crossing over is completed, the homologous chromosomes separate and this separation is called ***terminalization***. Terminalization may begin in chiasmata and move to the terminal end of the chromosomes.

Diakinesis

The nuclear membrane and the nucleolus disappear. The spindle apparatus is formed in the cytoplasm.

Metaphase - I

The chromosomes get condensed. Bivalents now appear on the equator of the spindle with their chromatids, pointing towards the equatorial plate and the centromere pointing towards the poles.

Anaphase - I

The spindle fibres contract pulling the chromosomes, towards the opposite poles. The entire chromosome, with the two chromatids move to the opposite poles. This involves, a reduction in the number

of chromosomes. Now two groups of chromosomes are produced, one at each pole with half the number of chromosomes.

Telophase - I

At the poles, around the group of chromosomes, a nuclear membrane develops. Thus two daughter nuclei each with half the number of chromosomes, are formed at the poles. The spindle fibres disappear.

At the end of Meiosis-I at right angle to the position of the nuclei, the cytoplasmic constriction takes place leading to the division of the cell. The cytoplasmic division is called Cytokinesis.

Meiosis - II

Meiosis-II is similar to Mitosis and so it is called Meiotic Mitosis. The events of Meiosis-II are studied in four sub-divisions as, Prophase-II, Metaphase-II, Anaphase-II and Telophase-II.

Prophase - II

The bivalent chromosomes gets shortened. The centrioles form asters and move to the poles. The nucleolus and nuclear membrane disappear.

Metaphase - II

Chromosomes, each consisting of two chromatids held together by a centromere are arranged at the equator of the spindle fibres. The centromeres are attached with the spindle fibres.

Anaphase - II

The centromere divides into two and the two chromatids separate and now they are called as daughter chromosomes or new chromosomes. The daughter chromosomes move towards the opposite poles.

Telophase - II

The haploid set at the two poles coil to form chromatin material. The nuclear membrane and nucleolus reappear. Thus two daughter nuclei are formed.

Cytokinesis

The cytoplasmic division takes place at right angles to the position of the nuclei ,resulting in the formation of four gametes.

Significance of Meiosis

1. Haploid sex cells are produced, in order to maintain the constancy in the number of chromosomes of a species.
2. Crossing over results in variation of genetic traits in the offspring.
3. Variations form the raw material for evolution.

3.4. HEREDITY

The resemblance of son or daughter with his or her father or mother, is an interesting feature in nature. Inheritance of characters from the parents to the progeny, (i.e heredity) ensures the passing of the parental characters to the progeny. The inheritance of characteristics through generations is called heredity.

The inheritable characters may be morphological or physiological or anatomical or reproductive and are also known as traits. Both the mother and father contribute equal amount of genetic material to the child. This means, that each trait can be influenced, by both paternal and maternal genetic material i.e DNA.

EVALUATION

Part A

1. Unipolar neurons are found in ___________.

   Brain, Spinal Chord, Embryonic nervous tissue, Adult nervous tissue.

2. The sensory organs contain ___________.

   Unipolar neuron,Bipolar neuron, Multipolar neuron, Medullated neuron.

3. The part of brain which controls emotional reactions in our body is ____.

   Cerebellum, Cerebrum, Thalamus, Hypothalamus.

4. One of the following is the part of the brain stem. Pick out.

   Fore brain and mid brain, Mid brain and hind brain,

   Fore brain and hind brain, Fore brain and spinal cord.

5. Spinal nerves are ________.

   Sensory nerves, Motor nerves, Mixed nerves, Innervating the brain.

6. An endocrine gland found in neck is ___________.

   adrenal gland, pituitary gland, thyroid gland, pancreas.

7. An endocrine gland which is both exocrine and endocrine is _______.

   (pancreas, pituitary, thyroid, adrenal).

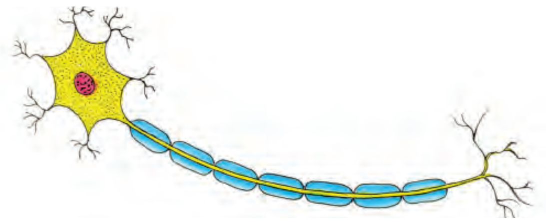
8. Normal blood glucose level in 100 mlof blood is _________.

9. The "T" lymphocytes are differentiated to resist infection in _____. (parathyroid gland, lymph gland,thymus gland, adrenal gland).

10. In Meiosis-I, the pairing of homologous chromosomes take place during _____ stage. (leptotene, zygotene, pachytene, diplotene)

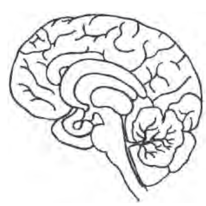
Part B

11. Copy the diagram and label any two parts in the group given.



(cyton, axon, dendron, endplate)

12. This diagram is human brain, and the functions of different parts are given below.



A. Seat of smell
B. Seat of vision

Mark A and B in the parts of the brain, Corresponding with the function.

13. On the basis of the function performed, Pick out the right statements.
    a. Pituitary gland secretes hormones and enzymes
    b.Thyroid gland secretes thyroxine and insulin.

c. Testes produces sperms and the hormone androgen.

d. Pancreas produces enzymes and harmones.

14. Based on relationships fill in the blanks.

Thyroxine: personality hormone; adrenaline :_________.

15. Correct the statements if they are wrong.

a .alpha cells produce insulin and beta cells produce glucagon

b. cortisone suppresses the immune response

c. thymus gland is a lymphoid mass.

d. Ovary produces eggs and Androgen..

16. Reduction division is the process by which gametes are produced,. The cells in which reduction division take place are

(germinal epithelial cells, the sensory epithelial cells,cuboidal epithelial cells,columnar epithelial cells.)

17. In Amoeba, the cell division takes place ———————

(involving changes in the chromatinreticulum,

without involving changes in the chromatin reticulum,

leading to reduction in the number of chromosomes,without dividing the nucleus.)

18. Pick out the item which has sequential arrangements

a. zygotene -> Leptotene -> Pachytene -> Diplotene -> Diakinesis

b. Diakinesis -> zygotene -> Leptotene -> Pachytene -> Diplotene

c. Leptotene -> zygotene -> Pachytene -> Diplotene -> Diakinesis

19. The important event of meiosis is the crossing over. It occurs during

(Leptotene,Pachytene,Diplotene, Zygotene.)

FURTHER REFERENCE

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2. Biology - A Modern Introduction, **B.S. Beckett,** Second Edition Oxform University Press.

Chapter 4

REPRODUCTION IN PLANTS

REPRODUCTION IN PLANTS

Do you know that all living organisms reproduce (both plants and animals)? Reproduction is a special biological process, by which new individuals of the same species are produced. It is one of the biological processes like nutrition, respiration and excretion etc.

What will happen if there is no reproduction?

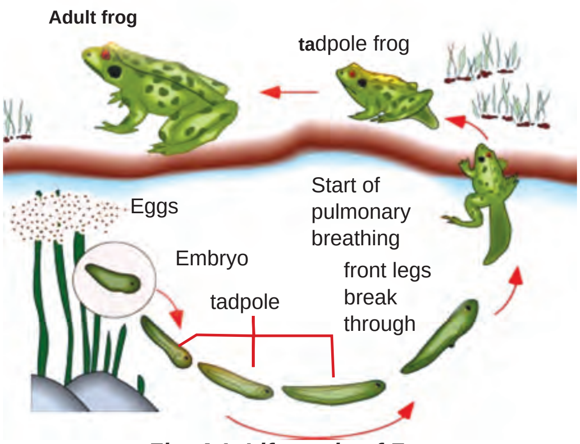


Fig. 4.1 Life cycle of Frog

Some of the methods of reproduction in organisms are:

Reproduction in animals	Reproduction in plants
Fission – Protozoan	Fission – Bacteria
Budding – Coelenterates	Budding - yeast
Fragmentation – Flatworms	Fragmentation – Algae
	Spores – Fungi
Sexual reproduction – Mammals	Pollination and Fertilization – Flowering plants

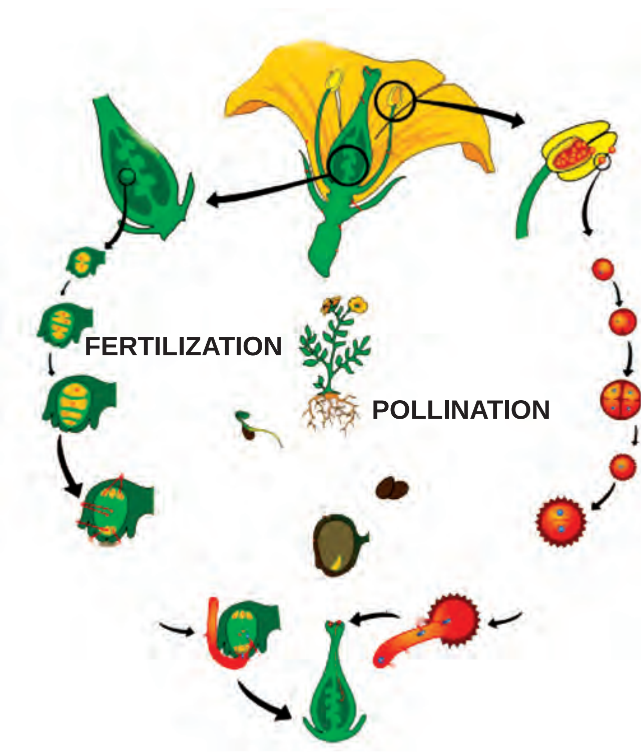


Fig. 4.2 Pollination and fertilization

Questions

1. What is meant by reproduction?
2. Mention a few methods of reproduction in plants and animals.

South African fossil records show that the first formed organism in the Earth is a Bacterium, i.e, Eobacterium which came into existence approximately four billion years ago. In the past two billion years, life got diversified into multitude of varieties of organisms that exist today or existed and became extinct in the past, whereas bacteria continues to live as bacteria without much change.

4.1. MODES OF REPRODUCTION

4.1.1. Modes of reproduction in single cell organism

Let us examine how different organisms actually reproduce. The methods by which organisms reproduce depend upon the body shape and structure of organisms.

Unicellular organisms, like amoeba and bacteria, split into two equal halves and produce new ones which is called binary fission.

Some Bacteria, like Lactobacilli, Salmonella multiply rapidly, others like Mycobacterium tuberculosis, multiply slowly.

ACTIVITY 4.1

- Wet a slice of bread and keep it in a cool, moist and dark place.
- Observe the surface of the slice with a magnifying glass.
- Observe for a week and record.

Beneficial activity to humans :

Conversion of milk into curd by Lactobacilli

Harmful activity to humans :

Bacteria like Mycobacterium tuberculosis cause tuberculosis.

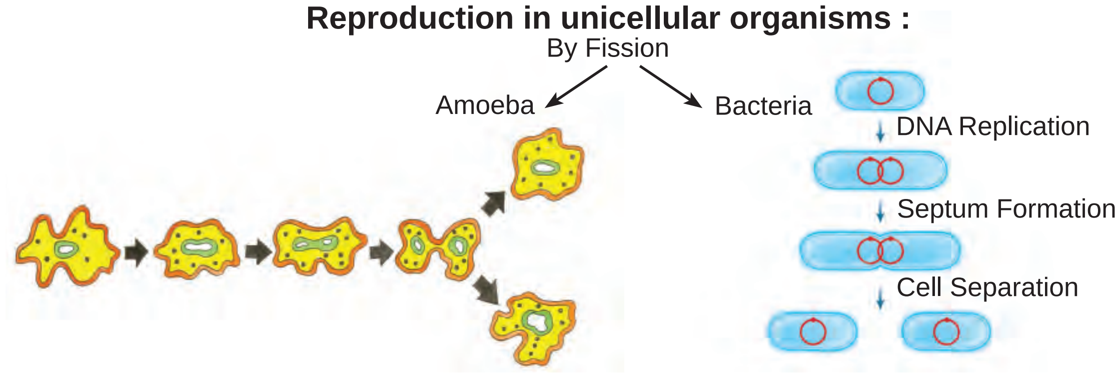


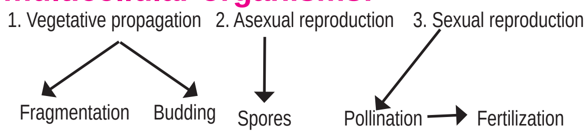
Fig. 4.3 Reproduction in unicellular organisms

> **Think, read and analyse,**
>
> **why there are so many methods of reproduction?**
>
> Evolution may be defined as a gradual development of more complex species from pre-existing forms. On this basis, the reproduction in simpler forms, like Amoeba and Bacteria, is very primitive by means of Binary Fission, Fragmentation, etc., If, the complexity of the body design of organisms increases, the method of reproduction also gets complicated involving two organisms (male and female).

ACTIVITY 4.2

- Observe a permanent slide of bacteria under a microscope.
- Similarly, observe another permanent slide of bacteria showing Binary Fission.
- Now compare the observations of both the slides.

4.1.2. Modes of reproduction in multicellular organisms:



Depending upon the body organization of multicellular organisms, there are various methods of reproduction.

Vegetative propagation: is the ability of plants to reproduce by bringing forth new plants from existing vegetative structures without sexual rproduction.

Fragmentation

In multicellular organisms with simple body organization, simple reproductive methods have been noticed.

In Spirogyra algae, the plant body breaks up into smaller fragments. Each fragment grows into a new individual.

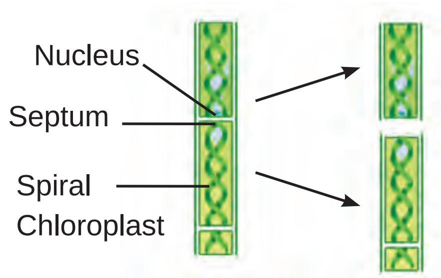


Fig. 4.4 Fragmentation in spirogyra

ACTIVITY 4.3

- Collect water from a lake or pond that appears dark green and contains filamentous structures.
- Put one or two filaments on a slide.
- Put a drop of glycerin on these filaments and cover it with a cover slip.
- Observe the slide under a microscope.

Budding

In Hydra, a bud develops as an outgrowth due to repeated cell division at one specific site. These buds develop into tiny individuals and, when fully mature, get detached from the parent body to become new independent individuals.

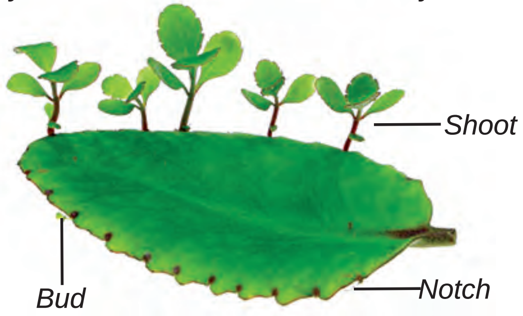
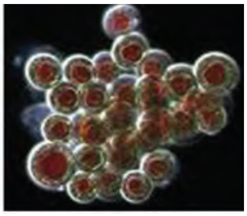


Fig. 4.5 Bryophyllum

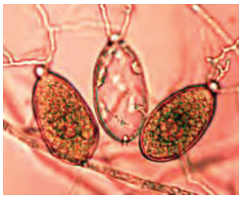
Similarly, buds produced in the notches along the leaf margin of Bryophyllum fall on the soil and develop into new plants (in Tamil katti pottal kutti podum).

4.1.3. Asexual reproduction

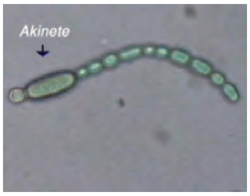
In lower group of plants, reproduction takes place by means of spores. The spores are covered by thick walls that protect them until they come into contact with another moist surface and can begin to grow.



Aplanospores



Zoospores



Akinetes

Conidia

Fig. 4.6 Different kinds of spores

Some of the spores in different algae and fungi are

APLANOSPORES	ZOOSPORES	AKINETES	CONIDIA
In algae, the protoplast of the vegetative cells contract and produce ovoid bodies surrounded by a thin wall. These thin walled non-motile spores are called Aplanospores. New filaments are formed by the germination of these spores.	A zoospore is a motile asexual spore that uses a flagellum for locomotion. These spores are created by some algae, bacteria and fungi to propagate themselves.	In algae, the vegetative cells secrete thick additional wall layers. During adverse conditions, food materials are filled up in cells. These structures are called akinetes. When the Zable, they develop into new filaments.	Conidia are uninucleate, non-motile, asexual spores produced by the fungus like penicillium, etc.

Questions

1. *Differentiate vegetative propagation and sexual reproduction.*
2. *Mention some of the spores of asexual reproduction.*

4.1.4. Sexual reproduction in plants

What is sexual reproduction?

Sexual reproduction is the process in which two components (male and female) are involved to produce offsprings of their own kind.

A bull alone cannot produce new calves. It needs a cow. Female sheep alone cannot produce new ones. It needs a male sheep.

Both the sexes, male and female, are needed to produce new offspring.

As you have already studied in your earlier classes, the flower is a reproductive organ of a flowering plant. To understand this we need to look first at the structure of a flower.

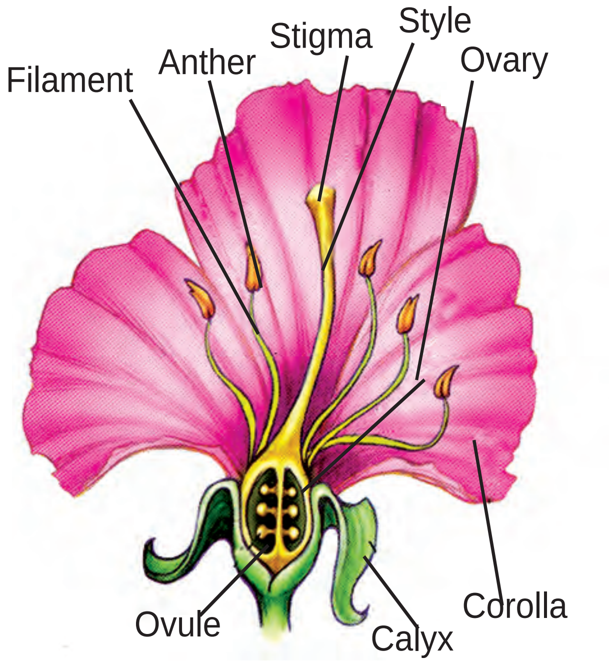
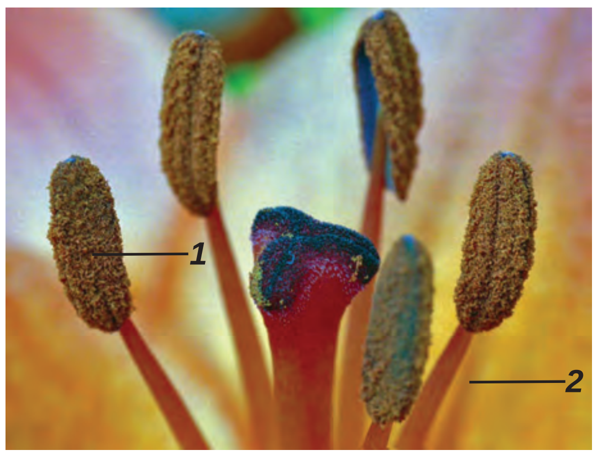


Fig. 4.7 Parts of a flower

Parts of a typical flower

A flower is a modified shoot with a limited growth. Flowers vary in size, shape,structure and colour.



1. Anther,

2. Filament

Fig 4.8 Androecium

The main parts of a flower are,

1. *Calyx*
2. *Corolla*
3. *Androecium and*
4. *Gynoecium.*

Androecium is the male part of a flower,and Gynoecium is the female part.

Androecium is a group of stamens. Each Stamen consists of a stalk called the filament and a small bag like structure called the anther at the tip. The pollen grains are contained in the anther within the pollen sacs.

Gynoecium

Gynoecium is the female part of the flower and consists of the carpels or ovary. Gynoceium has three parts 1) Stigma 2) Style and 3) Ovary.

The ovary contains the ovules and each ovule carries within it an embryo sac, within which lies the egg cell or the female gamete.

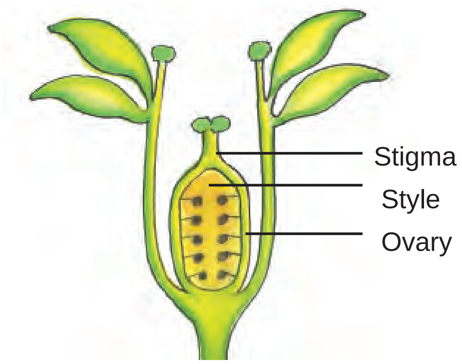


Fig. 4.9 Gynoecium

ACTIVITY 4.4

- Take a shoe flower from a growing plant.
- Observe the floral parts Calyx, Corolla, Androecium and Gynoecium.
- Separate the stamens and carpels and observe the parts.
- Dust the pollen grains on a slide and observe under the microscope.

4.2. POLLINATION

How does sexual reproduction take place in flowering plants?

The sexual reproduction in flowering plants involves

1. Pollination
2. Fertilization

1. Pollination

Transfer of pollen grains from the anther to the stigma is called pollination. Pollen grains are transferred mainly by wind, water and insects. They are called as pollinating agents.

Pollination is the first and important event in the development of the fruit and seed. Pollination is followed by fertilization.

Types of Pollination

Pollination is of two types. They are

1. Self pollination

2. Cross pollination

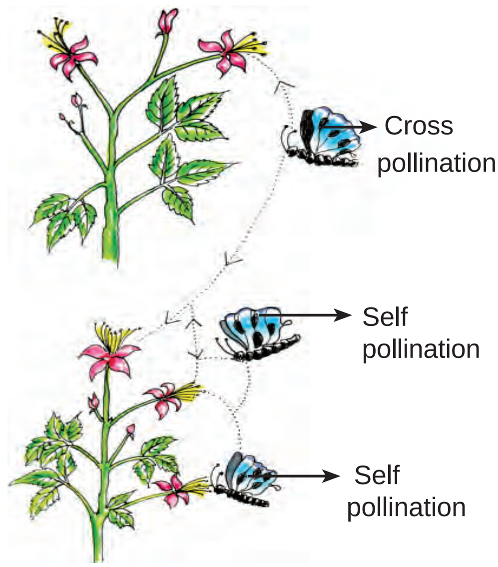


Fig. 4.10 Pollination

4.2.1. Self Pollination

Self pollination is also known as autogamy. The transfer of pollen grains from the anther of a flower to the stigma of the same flower or another flower of the same plant is known as self pollination.

Advantages of self pollination

1. Self pollination is certain in bisexual flowers.
2. Flowers need not depend on agents of pollination.
3. There is no wastage of pollen grains.

Disadvantages of self pollination

1. The seeds are less in number.
2. Endosperm is minute. Therefore, the seeds produce weak plants.
3. New varieties of plants cannot be produced resulting in the degradation of the plant.

4.2.2. Cross Pollination (Allogamy)

The transfer of pollen grains of a flower to the stigma of another flower of a different plant of the same species is called cross pollination or allogamy.

Advantages of cross pollination

1. The seeds produced as a result of cross pollination develop, germinate properly and grow into better plants, i.e., cross pollination leads to the production of new varieties.
2. More viable seeds are produced.

4.2.3. Agents of cross pollination

How is it possible for the transfer of pollen grains from one flower to another?

In order to bring about cross pollination, it is necessary that the pollen should be carried from one flower to another of a different plant. This takes place through agency of animals, insects, wind and water.

Pollination by birds (Ornithophily)

Pollination by insects and animals

ACTIVITY 4.5

Observe the flowers in a garden near to you.Identify the insects, and birds,that act as pollinating agents. Maintain a record detailing the pollinating agents and the plants they pollinate

Zoophily

Animals and insects – Birds, squirrels and insects are attracted to the bright petals of the flowers. These flowers are also large in size and have a sweet smell. Some of these flowers have nectar and a sweet scent. This is the most common of all methods of pollination. This kind of pollination is called Zoophily. (Pollination by animals and birds).

Fig. 4.11 Zoophily

Anemophily (Pollination by wind)

The flowers pollinated by air are mostly small in size and without any attractive colour, smell and nectar. They produce a large number of pollen grains to make up for the wastage of pollen in times of transit.

Fig. 4.12 Anemophily

The pollen grains are dry and powdery, and hence are easily carried by the wind.

Some pollen grains even have wings. Stigmas are large and protruding, even branched and feathery. e.g.Maize.

Flowers pollinated by wind are called Anemophilous, e.g. Grass and pine.

ACTIVITY 4.6

- Collect some of the zoophilous, anemophilous,hydrophilous flowers.
- Prepare a chart and make a note of their adaptations to suit the corresponding pollination.

Pollination by Water (Hydrophily)

This pollination takes place in water plants or plants that are adapted to water habitat. e.g. Vallisneria. This pollination is known as hydrophily. The flowers are small and inconspicuous.

Fig. 4.13 Hydrophily

4.3. FERTILIZATION

Recall what you have studied about pollination.

Pollination is the transfer of pollen grains from the anther to the stigma. Each pollen grain has protective walls called exine and intine. The outer wall exine is thick and it has small pores called germination pores. The inner wall is thin and elastic.

Germination of pollen grain

If pollen grain falls on a suitable stigma, it starts germinating. A mature pollen consists of two cells. The larger one is vegetative cell and the smaller one is generative cell. The vegetative cell starts growing and emerges through the germination pore. It develops through the style as a long tube known as pollen tube. The generative cell gets into the tube and divides into two male gametes (sperms).

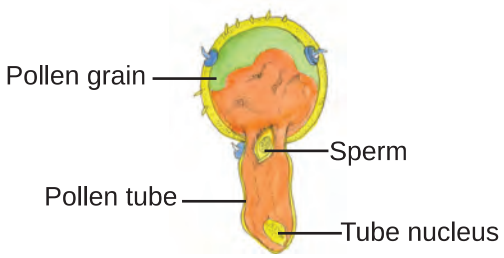


Fig. 4.14 Germination of pollen grain

4.3.1. Process of fertilization

The pollen tube enters into the embryo sac through micropyle. At this time, the pollen tube bursts open, gametes released from the pollen tube and enter into the embryosac. One of the gametes fuses with the egg, and the other fuses with the secondary nucleus. The fusion of a male gamete with egg is known as fertilization. The fertilized egg is known as zygote which develops into embryo.

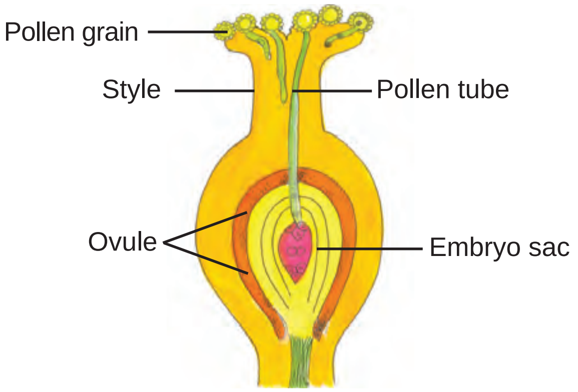


Fig. 4.15 Process of fertilization

4.3.2. Double fertilization

The other male gamete fuses with the secondary nucleus. The secondary nucleus is diploid in nature.

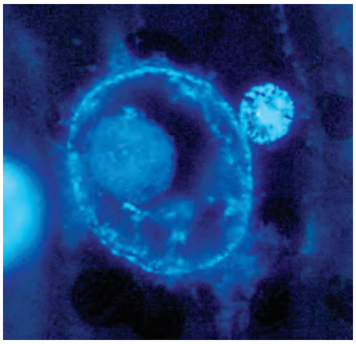


Fig. 4.16 Double fertilization

The fusion of this nucleus with the second male gamete is known as triple fusion. The triple fusion nucleus is called endosperm nucleus because it develops into endosperm.

Endosperm is a nutritive tissue meant for the development of the embryo. The process of fusion of a male gamete with egg and the other gamete with secondary nucleus is known as double fertilization.

4.3.3. Post fertilization changes :

i. The ovule develops into seed.
ii. The integuments of the ovule develop into seed coats.
iii. The ovary enlarges and develops into fruit.

4.4. FRUIT FORMATION

You are all very familiar with fruits. They are inseparable with us in our day-to-day life. Fruits are rich in vitamin and give energy to us. Now let us discuss about the development of fruits and their types.

As we discussed earlier, fruits are the product of fertilization. The ovary will become fruit after fertilization. It has two parts namely pericarp (fruit wall) and seeds.

Some fruits develop without the act of fertilization. Such fruits are called Parthenocarpic fruits. e.g. seedless grapes, guava, mango etc.

4.4.1. Classification of fruits

The fruits are classified as follows:

Simple fleshy fruits

In simple fleshy fruits, the pericarp is succulent and juicy when fully ripe. The fleshy fruits are indehiscent in nature. The pericarp is distinguished into three parts, namely epicarp, mesocarp and endocarp. There are mainly two types of fleshy fruits – Baccate and Drupaceous. Baccate is further classified into berry, hesperidium, pome and pepo.

Simple dry fruits

These fruits have a dry pericarp. They are classified based on mode of dehiscense as dry dehiscent, dryindehiscent and schizocarpic fruits.

4.4.2. Dry dehiscent fruit

These fruits split open at maturity to liberate the seeds.

4.4.3. Dry indehiscent fruit

These fruits do not split open at maturity and the seeds are liberated by the decay of pericarp

4.4.4. Schizocarpic fruits

At maturity, these fruits break into many one seeded parts called mericarps. The mericarps containing the seeds remain indehiscent. Thus the schizocarpic fruits show characters of dehiscent and indehiscent fruits.

4.4.5. Aggregate Fruit

It is developed from a single flower with multicarpellary, apocarpous, superior ovary.Each free carpel develops into a fruitlet. Hence, the aggregate fruit has a cluster of fruitlets attached to a common stalk (e.g) Polyalthia

In Annona squamosa (custard apple), the margin of the carpels are united and appears like a single fruit.

Fig. 4.17 Polyalthia

Fig. 4.18 Custard apple

4.4.6. Composite or Multiple fruit

Multiple or composite fruit is formed by all the flowers of whole inflorescence and give a single fruit. There are two types of multiple fruits namely sorosis and syconus.

ACTIVITY 4.7

Collect a variety of fruits. Identify what type of fruit they belong to and make a note on them.

Think, read and find out :

Why are there so many varieties of fruits?

4.4.7. Seed Formation

Seed is a fertilized ovule. It possesses embryo, food materials and are protected by the seed coat. During favourable condition, the seed germinates and gives rise to a new seedling.

Seeds have great variations in the size, shape, colour and surface. In orchids, there are many seeds which are tiny dust like particles. In coconut, there is a large sized seed. The seed grows into a full plant.

On the basis of the number of cotyledons in the embryo (seed), the angiosperms have been divided into two groups.

Simple fleshy fruits

Sl.No	Type	Diagram	Description
1.	Baccate-Berry	Tomato 	It is one or many seeded fruit. Epicarp is thin and the mesocarp is fleshy. They form a pulp which is edible and the seeds are embedded in it.
2.	Hesperidium	Orange 	It develops from multicarpellary, superior ovary with axile placentation. The epicarp is thick, leathery and contain oil glands. The whitish spongy layer lining the epicarp is called mesocarp. The endocarp forms distinct chambers. Juicy hairs produced from the endocarp is the edible part.
3.	Pome	Apple 	The fruit develops from pentacarpellary syncarpous inferior ovary with many seeds. The thalamus becomes fleshy and develops into a fruit which is edible. The true fruit containing seeds remain inside.
4.	Pepo	Cucumber 	It develops from a tricarpellary, syncarpous inferior ovary with parietal placentation.The pulp contains many seeds.
5.	Drupaceous Drupe	Mango 	It is a one seeded fleshy fruit and develops from monocarpellary, syncarpous ovary. The pericarp is differentiated into outer skinny epicarp,fleshy middle mesocarp and stony inner endocarp. Because of the presence of stony endocarp, the fruit is also known as stone fruit.

BIOLOGY

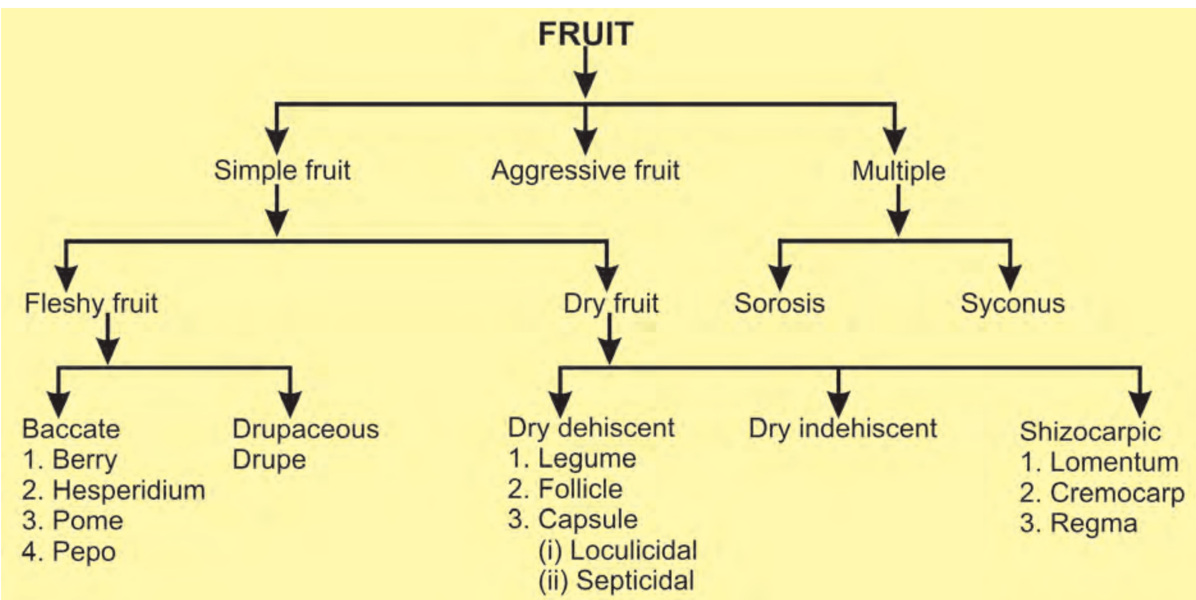
Simple dry fruits   *Dry dehiscent fruits*

Sl.No	Type	Diagram	Description
1.	Legume	Beans 	It develops from monocarpellary, unilocular, superior ovary with marginal placentation. Pericarp dehisces along both dorsal and ventral sutures (e.g.) pea, bean, etc.
2.	Follicle	Calotropis 	It is like a legume fruit, but the pericarp dehisces along one suture only. (e.g.) Calotropis.
3.	Capsule (a) Septicidal capsule (b) Loculicidal capsule	Cotton  Lady's finger 	This is a many seeded fruit developing from superior or inferior, syncarpous multicarpellary ovary. Capsules dehisce by various methods.

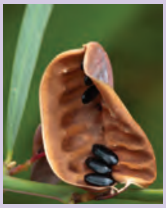
Dry indehiscent fruits

Sl.No	Type	Diagram	Description
1	Achene	Clematis,Mirabilis 	This is a single seeded fruit which develops from monocarpellary, unilocular ovary. Pericarp is hard and leathery, remains free from the seed coat

2.	Caryopsis	Paddy 	It is a one seeded fruit which develops from superior mono-carpellary ovary. Pericarp is fused with the seed coat (e.g paddy, wheat, maize).
3.	Cypsela	Tridax 	This fruit develops from inferior, bicarpellary syncarpous ovary. The pericarp and the seed coat remains free (e.gTridax).
4.	Nut	Cashew nut 	It is a dry indehiscent, one seeded fruit with hard and woody pericarp. Nut is developed from superior, bi or multi-carpellary ovary (e.g. Cashew nut, Walnut etc).



Schizocarpic Fruits

Sl.No	Type	Diagram	Description
1.	Lomentum	Acacia 	It resembles a legume and breaks transversely at constrictions between the seeds (e.g Acacia).
2.	Cremocarp	Coriandrum 	It is a two seeded fruit which develops from bicarpellary syncarpous, bilocular and inferior ovary. It dehisces longitudinally into two indehiscent mericarps (e.g) Coriandrum.
3.	Regma	Castor 	It develops from tricarpellary syncarpous superior ovary and breaks up into three one seeded cocci (e.g Castor).

Composite Fruits

Sl.No	Type	Diagram	Description
1.	Sorosis	Jack fruit 	In jack fruit, the rachis (inflorescence axis) and other floral parts of the female inflorescence fuse together forming a composite fruit. It consists of a fleshy central axis. The edible part represents the perianth which is bag like and one seeded. There are numerous, elongated, whitish flat structures in between the edible flakes. They represent the sterile or unfertilized flowers. The pines on the tough rind represent the stigma of the carpels.

Sl.No	Type	Diagram	Description
2.	Syconus	Fig 	It is derived from a special type of inflorescence known as hypanthodium which has a fleshy receptacle. It has large number of minute unisexual flowers. On ripening, the receptacle becomes fleshy and juicy and forms the edible portion (e.g.) banyan, peepal , fig, etc.

1. Dicotyledons: Seeds with two cotyledons (e.g) pea, bean, gram and castor.

2. Monocotyledons: Embryo with one cotyledon (e.g) maize, rice, wheat and onion.

1. Structure of a dicot seed (bean)

The seed is bulky, oval and slightly indented on one side. On this side there is a short longitudinal, whitish ridge called the raphae. At one end of the raphae there is a minute opening known as germ pore or micropyle.

If a water soaked seed is pressed gently a small drop of water along with air bubbles will be found coming out though the micropyle.

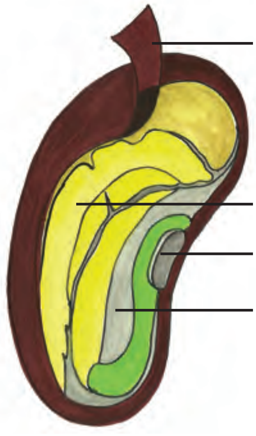


Fig. 4.19 Dicot Seed (Bean)

The embryo is enclosed by the seed coat. It consists of cotyledons attached to the primary axis which has rudimentary root portion called the radicle and a rudimentary stem portion known as plumule.

The tip of the radicle projects outside ,and is nearer to the micropyle. The plumule is placed between the two cotyledons and consists of a short axis, and a small bud having two tiny little folded leaves.

2. Structure of monocot seed (paddy)

In paddy, the so called seed is actually a fruit. It is a simple indehiscent one seeded fruit known as caryopsis, (you have already studied about this in the lesson of fruits.).The seed coat is very thin. The fruit wall (pericarp) is thin and fused with the seed coat. The fruit is covered by generally yellowish bract and bracteoles which are commonly known as chaff. The embryo consists of single cotyledon called scutellum and a short axis. The lower part of the axis is the radicle, covered by a sheath called coleorrhiza (root sheath). The upper part is known as plumule which is covered by a sheath called coleoptile. In a day or two, after the seed is placed in a moist soil, the coleorrhiza pierces the base of the seed. The radicle comes out next after splitting the coleorhiza.

The radicle does not form the root system. Meanwhile, roots are formed from the lower most nodes of the stem. These roots are called adventitious roots. These adventitious roots form fibrous root system of matured plant.

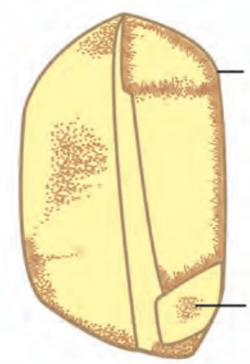


Fig. 4.20 Monocot seed (Paddy)

MORE TO KNOW

Darwin used seeds of cress, cabbages, lettuces and onions. Darwin also studied longer periods in sea water, the effect of water temperature on germination and floating of seeds. His experiments overturned the idea that sea water kills seeds. Of the 87 species he used, Darwin found almost three-quarters of the seeds studied could tolerate solt water at least 28 days in salt water.

ACTIVITY 4.8

Label jars, filled with sea water and seeds. After 7 days put the seeds in a sieve, rinse under a tap, and plant out in labeled pots.

ACTIVITY 4.9

- Soak a few seeds of bengal gram (Channa) and keep them over night in a wet cloth.
- Take care that the bengal gram is not swollen absorbing exess of water. (The bengal gram should not be decayed with excess water.
- Drain the excess water and cover the seeds with the wet cloth and leave them for a day. Make sure that the seeds do not become dry.
- Cut and open the seed carefully and observe the different parts.
- Compare your observations with the diagram and see if you can identity all the parts.

4.5. Dispersal of seeds :

The seeds fall off far away from the mother plant. Why?

The reproductive capacity of plants is so tremendous that a very large number of seeds is produced by a single plant. If all these seeds fall directly below the parent plant, the seedlings would have to compete for space, water, oxygen, minerals and sunlight, leading to competition. When the seedlings are grouped together at one place, they could easily be destroyed by grazing animals. Such a situation would be detrimental to the species.

The fruits and seeds of plants have evolved various devices by which they can be distributed far and wide through various agencies.

This not only eliminates the unhealthy competitive struggle that would arise from over crowding, but also ensures the successful spreading and establishment of a species on the earth. Most fruits and seeds have evolved adaptations for dispersal.

Agents for the dispersal of fruits and seeds:

Based on the agents involved in dispersal, there are various types of dispersal mechanisms of fruits and seeds in plants.

Autochory: Autochory is an active mechanism of self dispersal of fruits and seeds. Fruits like Balsam burst with a sudden jerk and disperse the seeds by an explosive mechanism.

Anemochory is the wind dispersal of fruits and seeds. Alternatively, the wind may blow them away, for which they have to be light, so that their buoyancy may enable them to float on air over long distances. Some of them are provided with hairs and membranous wing-like structures which enable them to be carried away easily (e.g. Seeds dispersed by the wind are Calotropis (Erukkum), Moringa (drum sticks) etc.,

Fruits of Tridax carry a persistent calyx modified into a pappus (a ring of fine, feathery hairs) which act like a parachute and aids in the dispersal by wind.

Hydrochory: Hydrochory is a mechanism in which dispersal of fruits and seeds is by water. Fruits which are dispersed by water have outer coats that are modified to enable them to float. The mesocarp of coconut is fibrous, which is easily carried away by water currents.

The spongy thalamus with air chamber of Lotus floats in water streams and after some time the fruits get separated, and the seeds germinate.

Zoochory: Zoochory is a mechanism in which dispersal of fruits and seeds is by animals. Some fruits are provided with hooks, spines, bristles, stiff hairs, etc., on their outer coat. With the aid of these out growths, these fruits stick to the furry coats of skins of some animals and get carried away from one place to another.

The fruits of Xanthium have sharp-pointed stiff hooks and the Achyranthus the perianth and bracts are pointed. Many fleshy fruits are eaten by animals and human beings and the seeds are thrown away.

Fig. 4.21 Autochory (Balsam)

Fig. 4.22 Anemochory (Tridax)

Fig. 4.23 Hydrochory(Lotus)

Fig. 4.24 Zoochory(Xanthium)

Fig. 4.25 Zoochory(Achyranthus)

In fruits like tomato and guava, the seeds are eaten along with the edible portion and later passed out by excreta. These types of seeds are protected from the digestive juices by their seed coat.

Man is responsible for the dispersal of many fruits and seeds. In the pursuit of more economy, useful plants like Cinchona, Rubber and Eucalyptus have been successfully introduced by man and they have acclamalised well to the new surroundings far away from their original mother land.

ACTIVITY 4.10

- Collect a few fruit or seeds which have wings.
- Observe the fruit of Tridax and draw. Look at the pappus calyx.
- Why is the mesocarp of coconut fibrous?

Collect some of the plants around you. What are their local names?

Can you find out their botanical names?

EVALUATION

PART A

1. This is the one of the methods of reproduction in unicellular organisms like amoeba and bacteria in which they split into two equal halves and produce new ones is called.
   (fragmentation, binary fission, budding, spore formation)
2. In sexual reproduction of flowering plants, the first event involved in this is.
   (fertilization, germination, regeneration, pollination)
3. Which of the following statement is true.
   (Thin walled non mobile spores are called zoospores,
   A motile asexual spore produced by some algae bacteria and fungi are Akinetes,

Uninucleate non-motile asexual spores are produced by the fungus are called conidia,
Thick walled vegetative cells produced by the algae during adverse conditions are called aplanospores.)

4. The fertilized ovary is a fruit. The fruit develops from a single flower with multi carpellary, apocarpous superior ovary is

   (Aggregate fruit, Composite fruit, Simple fruit, Multiple fruit)

5. If a water soaked seed is pressed, a small drop of water comes out through.
   (stomata, lenticel, micropyle, radicle)

6. The mango fruit is called as stone fruit. because it has.

   (skinny epicarp, stony mesocarp, fleshy endocarp, hard endocarp)

7. Pick out the wrong statement.
   (In a dicot seed there is a short longitudinal whitish ridge is called the raphae.
   There is a minute opening in dicot seed is known as micropyle.
   The rudimentary stem portion known as radicle.
   The rudimentary root portion is called radicle)

8. Consider the following statement regarding the dispersal of fruit by wind and select the correct answer.
   (Fruits and seeds dispersed with a sudden jerk by an explosive mechanism.
   Fruits of tridax are carry a persistent calyx modified into pappus.
   The fruits of xanthium have sharp pointed stiff hooks.
   The mesocarp of coconut is fibres)

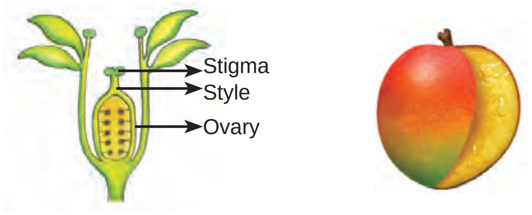
9. The product of triple fusion which acts as nutritive tissue for the development of embryo is
   (zygote, placenta, scutellum, endosperm)

10. The disadvantage of self pollination is
    (There is no wasteage of pollen grains,
    The seeds are less in number
    Self pollination is sure in bisexual flowers
    Flowers need not depend on agents of pollination

PART B

11. a. Identify the given fig. A and B.

    b. Which part of the A is modified in to B.



A *B*

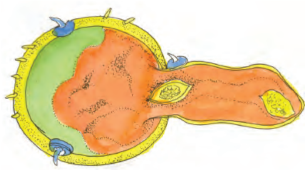
12. The methods of reproduction and the organisms are given below. Match the type of reproduction to the suitable organisms.

Fission	Spirogyra	Yeast
Budding	Protozoans	Flatworms
Fragmentation	Bryophyllum	Bacteria

13. In balsam plant the seeds fall off far away from the mother plant.
    a) Is this statement correct or incorrect?
    b) Give reason.

14. Composite fruits is formed by all the flowers of -------------, ------------ fruit is developed from a single flower with multicarpellary apocarpous superior ovary.

15. Redraw the diagram and label the following parts.
    a) Exine b) Tube nucleus.



PART C

16. a) Name the process by which the fruit is developed.
    b) Give the development process in brief.
    c) Draw a neat diagram of that process and label.

17. a) Write the two events involved in the sexual reproduction of flowering plant.
    b) Discuss the first event and write the types
    c) Give advantages and dis-advantages of that event.

18. a) Fruit is the product of fertilization. Is there any fruit is formed with out the act of fertilization?
    b) Represent the classification of fruits in a diagrammatic sketch

19. Compare aggregate fruit with multiple fruit with suitable examples.

20. Describe the structure of dicot seed.

FURTHER REFERENCE

Books:

1.Plant Reproduction - **S.R.Mishra** - Discovery Publishing House Pvt. Ltd.

NAME OF THE PLANTS IN ENGLISH AND TAMIL

S.No	Botanical Name	Common Name in English	Tamil Name	How it is called locally
1	Abelmoscus esculentus	Lady's finger	வெண்டை	
2	Acacia coccina	Soap acacia	சிகைக்காய்	
3	Achyranthes aspera		நாயுருவி	
4	Anacardium occidentale	Cashew nut	முந்திரி	
5	Anona squamosa	Custard apple	சீதாப்பழம்	
6	Artocarpus integrifolia	Jack fruit	பலா	
7	Bryophyllum		கட்டிப் போட்டால் குட்டிப் போடும்	
8	Calotropis gigantea	Madar plant	எருக்கு	
9	Citrus sinensis	Sweet orange	சாத்துக்குடி	
10	Cocus nucifera	Coconut	தென்னை	
11	Coriandrum sativum	Coriandar	கொத்துமல்லி/தனியா	
12	Gossypium arboreum	Cotton	பருத்தி	
13	Cucumis sativus	Cucumber	வெள்ளரிக்காய்/ தோசைக்காய்	
14	Cucurbita maxima	Pumpkin	பூசணிக்காய்/ பரங்கிக்காய்/ அரசாணைக்காய்	
15	Ficus glomerata	Fig	அத்தி	
16	Impatiens balsamia	Balsam	பால்செண்டு/பால்சம்	
17	Lablab purpurreus	Bean	அவரை	
18	Lycopersicon esculentum	Tomato	தக்காளி	
19	Mangifera Indica	Mango	மா	
20	Mimosa pudica	Touch me not plant	"தொட்டால்வாடி/ தொட்டால்சுருங்கி/ தொட்டால்சிணுங்கி"	
21	Mirabilis jalapa	Four o clock plant	"அந்திமந்தாரை/ அந்திமல்லிகை"	
22	Nelumbo nucifera	Indian lotus	தாமரை	
23	Oryza sativa	Paddy/ rice	நெல்	
24	Pisum sativum	Pea	பட்டாணி	
25	Polyalthia longifolia	Mast tree	நெட்டிலிங்கம்	
26	Pyrus malus	Apple	ஆப்பிள்	
27	Ricinus communis	Castor	ஆமணக்கு/ முத்துக்கொட்டை	
28	Tridax		வெட்டுக்காயப் பூண்டுச் செடி	

BIOLOGY

Chapter 5

A REPRESENTATIVE STUDY OF MAMMALS

5. A REPRESENTATIVE STUDY OF MAMMALS

Mammals are the diverged group of animals, occupying different biomes of the environment ,successfully fitting in their habitats. Mammals are found almost in all habitats like oceans , freshwater, hilly regions , forests, deserts, polar regions and swamps.

5.1. MORPHOLOGY

Mammalian morphology is so divergent, as they occupy different habitats . The sea living dolphins, whales etc., look like fish, by form and structure. A nocturnal bat gliding in the sky, looks like a bird. All the large land animals are mammals. The size of mammals sets them apart from all other kinds of land animals.

Mammals are distinguished from other vertebrates by two fundamental characteristics that all mammals possess and no other living vertebrate possess. They are

1. Epidermal Hairs
2. Milk producing glands.

Epidermal Hairs

All mammals have hairs, even apparently naked whales and dolphins grow sensitive bristles on their snouts. Mammalian hair is a new form of skin structure a derivative from the skin; the hair is an insulator against heat loss. The colouration and pattern of mammal's skin usually matches its background. Hairs also are sensory structure, as the whiskers of cats and dogs are sensitive to touch. Hair is also defensive for porcupine and hedgehogs with long, sharp, stiff hairs called ***quills*** to protect them from predators.

ACTIVITY 5.1

Observe the hair of dog, cat, cattles, man, horse and donkey. Look for the structural details like shape, texture and curly or straight condition and record your findings.

Milk producing glands

All female mammals possess mammary glands that secrete milk. New born mammals, born without teeth suckled by the mother. Milk producing glands are modified sweat glands.

5.2. HABITAT

The place of living of an organism is its habitat. Mammals exhibit a great degree of functional adaptation to fit in the habitats in which they live. We find mammals living in high mountains, plains and forests, tundra, grassland, deserts, fresh water and marine habitats. Some important mammals in their different habitats are listed below;

High mountains	- mountain goats, big horned sheep, grizzly bears, etc.,
Plains and forests	- porcupine, giant squirrel, deers,

	elephants, tiger, leopard, rhinoceros, Hippopotamus, etc.,
Tundra	- reindeer, muskdeer ox, rodents, etc.,
Desert	- black buck, Indian wild ass etc.,
Fresh water	- beavers, platypus, otters, etc.,
Marine	- whales, dolphins, dugong, porpoise, seal, walrus, etc.,

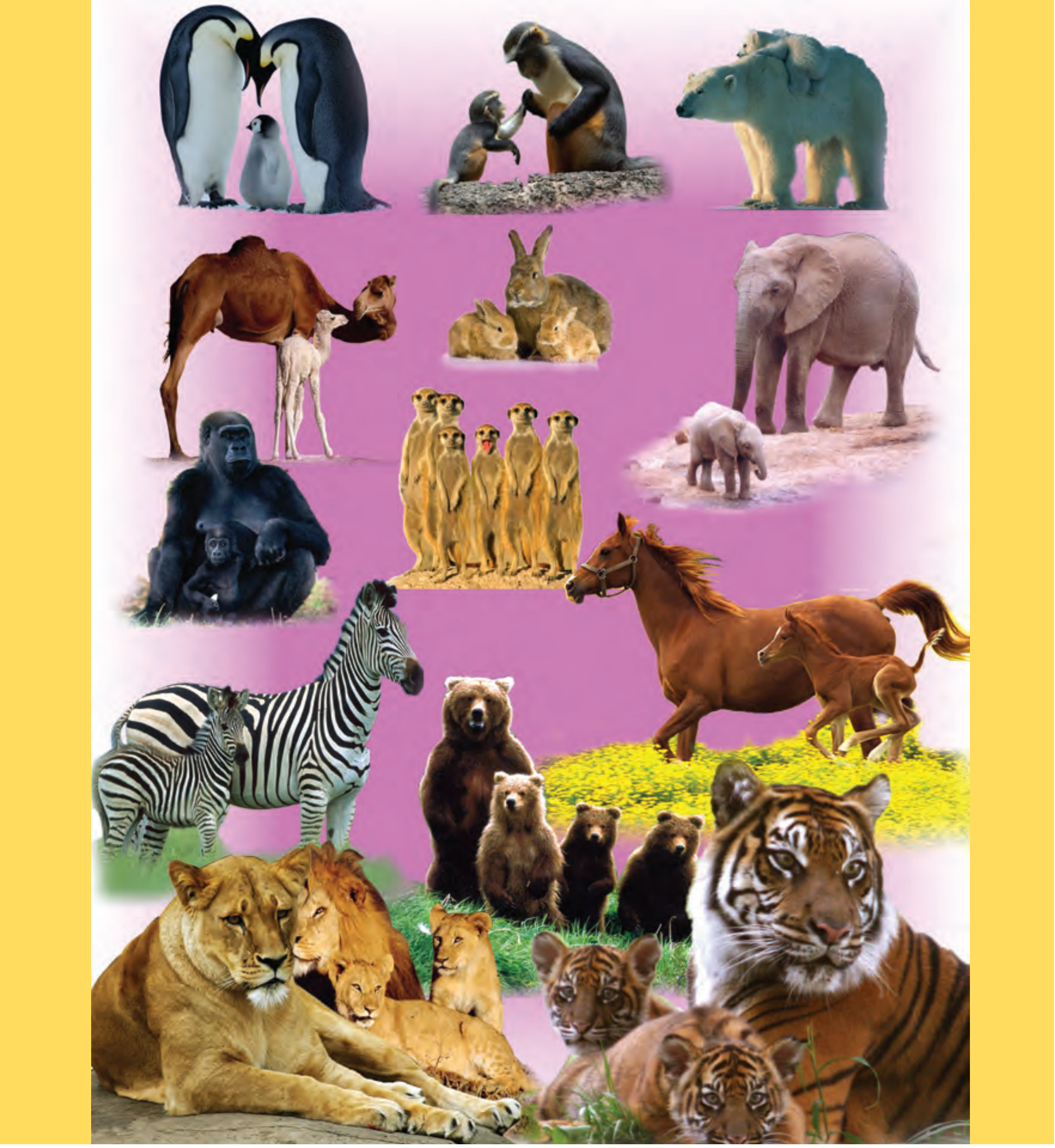


Fig. 5.1 Diverged group of mammals with their young ones

5.3. MAMMALIAN ADAPTATIONS

Mammalian group is the most successful animals adapted to different conditions of life.

i) In the marine whales, dolphins, etc,. the limbs are modified into flippers which are used as oars to swim in water. They also posseses huge subcutaneous fat deposits to conserve heat. The jaws of the whales are modified into baleen plates to sieve the water and trap the minute planktonic organisms as their food called krill.

ii) The skin of camels is doubly thick and contains water storing osmotic cells to conserve water, as they live in deserts. They have thick bunchy eyebrows covering the eyes to protect the eyes from sandy wind. Their nasal hole can be closed during desert storms to prevent the entry of sand particles.

iii) Most mammals are herbivores, eating mostly or only plants. To digest the cellulose rich food, they have developed a mutual partnership with bacteria that have cellulose splitting enzymes.

iv) Mammals such as cows, buffaloes, antelopes, goats, deers, etc,. have huge four chambered stomachs that function as storage and fermentation vats. The stomach of cattles also helps them to ruminate or cud the food.

v) Mammals have heterodont dentition with different types of teeth that are highly specialized to match particular eating habits. For example, the carnivorous animals have tearing teeth - the canine. In elephant the incisors are modified into tusks as a specialized weapon.

vi) Bats are the only mammals capable of powered flight. The forelimbs of bats are modified into wing like structure. The bat's wing is a leathery membrane of skin and the muscle is stretched over the bones of the four fingers. Bats prefer to hang upside down from their legs while resting. The nocturnal bats can fly without crashing into things and still capture insects by echo location. As a bat flies, it emits very rapid series of extremely high pitched clicking sounds. The sound waves bounce off objects or flying insects and the bat hears the echo.

vi) The marsupials, kangaroo have developed abdominal pouches to bear the tender young ones.

vii) The polar bears have thick skin coats and woolly fur to bear the biting cold of the polar regions.

viii) The supreme mammal – man is highly adapted as an intellectual social animal. The fingers and toes are adapted for handling extremely fine movements in holding of fine objects, in writing and using very delicate instruments.

Fig. 5.2 Bat

5.4. BASIC PHYSIOLOGICAL FUNCTIONS

Mammals perform the physiological functions more efficiently compared to other vertebrates.

Mammals are warm blooded or homeotherms, maintaining a constant body temperature, irrespective of the temperature in the surroundings. The body temperature in man is maintained at 98.4^o F to 98.6^o F. The temperature regulation is done as a team work, by the sweat glands of skin, kidneys, lungs and blood.

In summer, we sweat more as a cooling up mechanism, to conduct the heat out in the sweating process. This is possible with increased blood supply to the sweat glands. The kidneys expel less urine since much of water is lost in the sweat.

In winter, we produce little sweat as a warming up mechanism to conserve heat. The sweat glands are supplied with less amount of blood, so that the amount of heat lost is lowered. Now the kidneys excrete out more urine.

Mammalian respiration is more efficient in comparison to other vertebrates. Red blood cells of mammals are fully packed with the respiratory red blood pigment haemoglobin, to carry the maximum amount of oxygen. The mammalian RBCs are without nucleus, as the space occupied by the nucleus is taken up by the haemoglobin molecules.

ACTIVITY 5.2

Note the body temperature of some of your classmates at 10 a.m, 1 p.m and 4 p.m. Record the same. Do you find any change in the temperature at different timings?

5.5. CIRCULATORY SYSTEM OF MAN

In order to transport substances from one part of the body to the other, the circulatory system has evolved. In man, the circulatory system is composed of

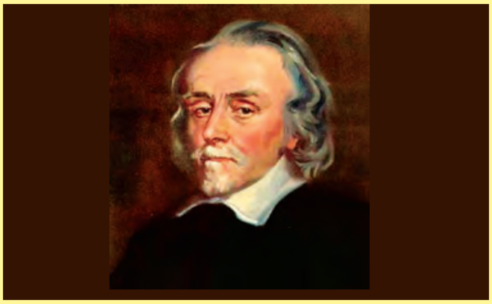
i) the heart

ii) the blood vessels namely arteries, veins and capillaries

iii) the blood and

iv) the lymph.

William Harvey in 1628 discovered the circulation of blood in man, until then it was thought that the body is a blood filled entity, and the blood is stagnant in it.



William Harvey 1578-1657 was an English physician. He was the first to give the details of blood circulation, the properties of blood and the pumping of blood by the heart.

The heart

The human heart is a hallow fibro muscular organ. It is conical in shape. the heart is covered by a protective double walled sac called ***pericardium*** filled with ***pericardial fluid***. The heart is made up of special type of muscles, called cardiac muscles. The partitions within the heart divide the heart into four chambers as auricles and ventricles. The right half of the heart receives and pumps off deoxygenated blood and the left half of the heart receives and pumps out oxygenated blood.

Auricles

These are thin walled upper chambers. The auricles are divided into a right auricle and a left auricle, by a partition called inter auricular septum. Auricles are the receiving chambers of blood. Into the right auricle open the superior venacava and inferior venacava emptying the deoxygenated blood brought from different parts of the body. Into the left auricle open the four pulmonary veins emptying the oxygenated blood brought from the two lungs.

Ventricles

These are thick walled lower chambers of the heart. A partition called inter ventricular septum divides the ventricle into right and left ventricle. The ventricles pump the blood out from the heart. From the right ventricle the deoxygenated blood is pumped into pulmonary artery to supply the two lungs. From the left ventricle oxygenated blood is pumped into the aorta to supply the oxygenated blood to the different parts of the body through its branches.

Apertures of the heart

Between the right auricle and right ventricle is found the right auriculo ventricular aperture and between the left auricle and left ventricle is found the left auriculo ventricular aperture.

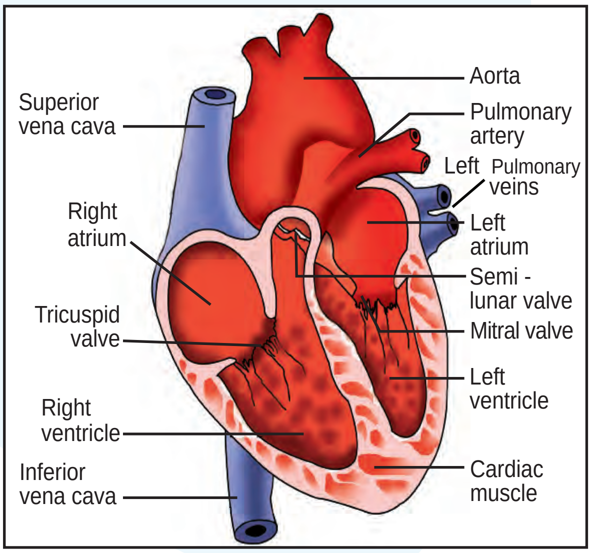


Fig. 5.3 Human heart

BIOLOGY

Valves of the heart

A tricuspid valve with three flaps is found in the right auriculo ventricular aperture to regulate the flow of blood, from right auricle to right ventricle and not backwards.

A bicuspid valve or mitral valve with two flaps in the left auriculo ventricular aperture regulates the flow of blood, from left auricle to left ventricle and not backwards.

At the base of the pulmonary artery is present the semi-lunar valve, which regulate the blood to flow from the right ventricle to the pulmonary artery.

At the base of the aorta is present the aortic valve, to regulate the flow of blood from left ventricle into aorta.

Working of heart

Human heart works by contraction and relaxation of the cardiac muscles. The contraction phase is called systole and relaxation phase is called diastole.

When the auricles are filled with blood they are in relaxation phase (auricular diastole). By now ventricles will push the blood into aorta and pulmonary artery by their contraction (ventricular systole).

When the auricles contract (auricular systole) the blood is pushed into the ventricules through the bicuspid and tricuspid valves, leading to ventricular relaxation (ventricular diastole).

Heartbeat

The closure of the valves of the heart produce two different cardiac sounds as ***"lubb"*** and ***"dubb".*** The human heart beats 72 times in a minute at rest. Heartbeat is an inherent capacity of the heart, begun and conducted by the specialized muscle bundle in the heart.

Blood vessels

There are three distinct types of blood vessels, namely, arteries, veins and capillaries.

Arteries

Arteries carry the blood from the heart to different parts of the body. They are the branches of aorta, supplying oxygenated blood to the different regions of the body (except pulmonary artery which carries deoxygenated blood). The aorta branches into arteries. Arteries branch into arterioles. Arterioles branch into fine tubes called meta arterioles. The meta arterioles end up in the tiny blood vessels called capillaries.

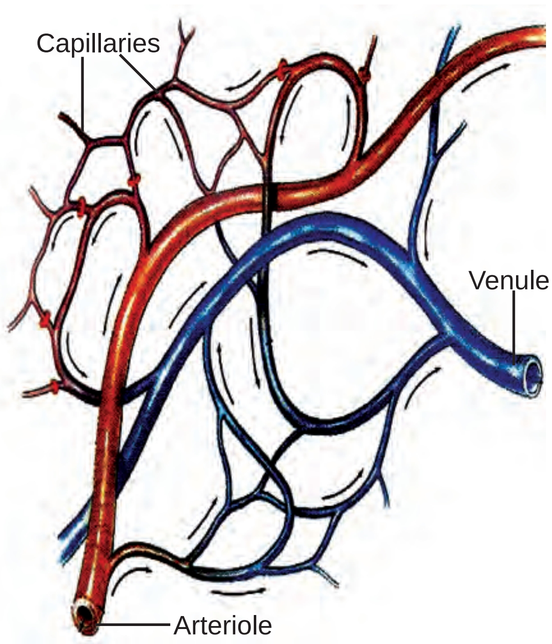


Fig. 5.4 Arteries, capillaries and veins

Capillaries

These tiny blood vessels form a network, called capillary network around the tissues to enable the passage of substances from the blood into the tissues.

Veins

The veins drain the blood from different parts of the body to the heart. The capillaries reunite to form venules, which drain the deoxygenated blood from the tissues. The small venules united with the big veins open into superior venacava and inferior venacava. Except the pulmonary veins all other veins carry deoxygenated blood.

The blood

Blood is the river of life – providing the internal environment to the body. Blood is the connective tissue, consisting of the fluid part, the plasma and the solid components, the blood cells.

Plasma

The liquid component of blood, the plasma is composed of water, organic substances, inorganics substances, etc,. The important organic substances of plasma are the plasmaproteins namely globulin (for immunity), fibrinogen (for blood clotting) and albumin (for water balance).

Blood cells

There are three types of blood cells namely Red Blood Cells, White Blood Cells and Blood Platelets freely floating in the plasma.

Red Blood Cells –Erythrocytes

RBCs are circular, biconcave and disc shaped. While the young RBCs have nuclei, the matured ones are without nuclei. The red blood pigment haemoglobin is fully packed in the RBCs. They are concerned with carriage of respiratory gases.

White Blood Cells – Leucocytes

WBCs are amoeboid in shape with prominent nuclei. WBCs are concerned with phagocytosis of engulfing the germs and producing antibodies to resist the germs entering the body.

Blood Platelets – Thrombocytes

Platelets are irregular broken up pieces of certain giant cells. They are concerned with blood clotting to prevent the loss of blood.

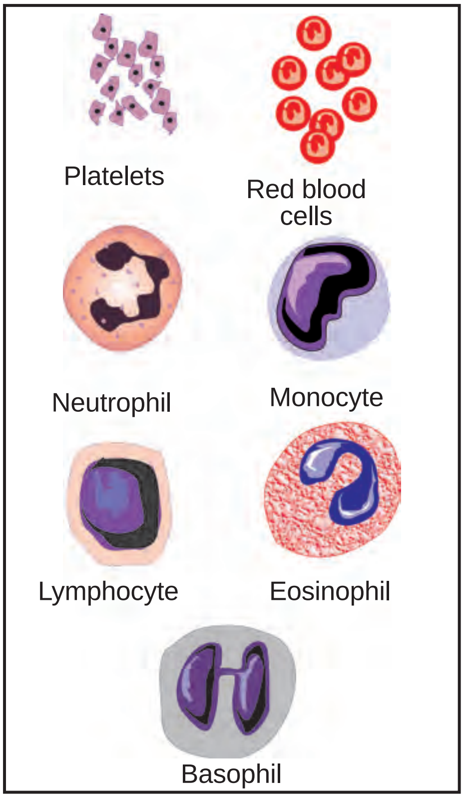


Fig. 5.5 Blood Cells

5.6. EXCRETORY SYSTEM IN MAN

Excretory organ	Excretory products	Sent out as
Kidneys	Nitrogenous waste products – urea, uric acid, creatinine, etc,.	Urine
Lungs	Carbondioxide and water vapour	Expired air
Skin	Excess water and salt	Sweat

Excretion is the removal of metabolic waste products called excreta. The important excreta and the excretory organs which remove them are shown in the above table.

The principal excretory organs of our body are the kidneys, which maintain the chemical composition of the blood and so are called as master chemist of our body.

External structure of kidney

A pair of kidneys are present in the upper abdominal region, one on either side of the vertebral column attached to the dorsal body wall. A thin transparent membrane called capsule covers the kidney. The kidneys are bean shaped with outer convex surface and inner concavity. The depression in the concavity is called renal hilus, from which arises the muscular tube called ureter. The two ureters open into the distensible muscular sacs called the urinary bladder which is the store house of urine. From the urinary bladder arises the urethra which delivers the urine out of the body.

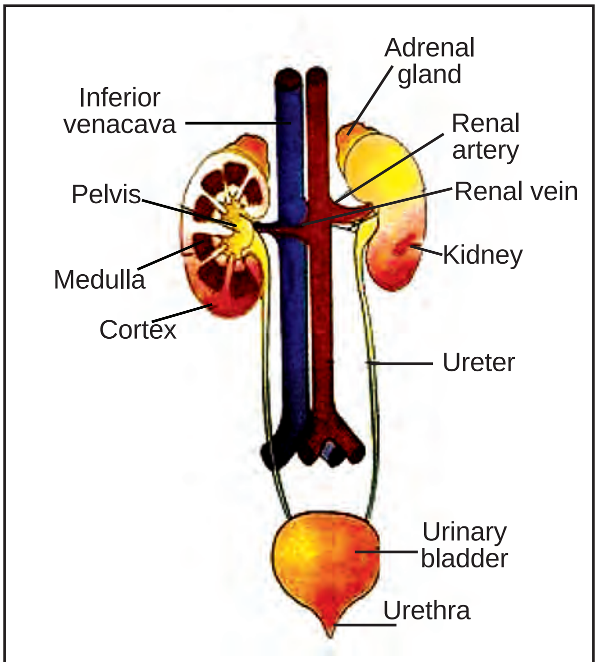


Fig. 5.6 Excretory system of man

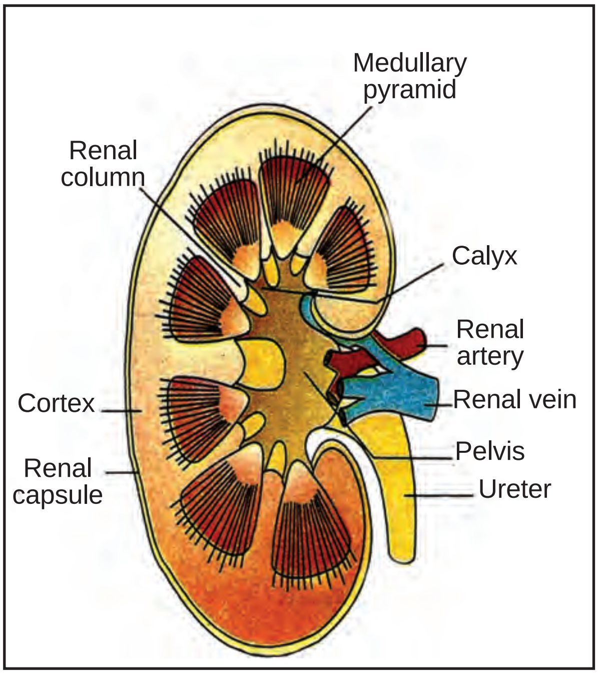


Fig. 5.7 LS of Kidney

Internal structure of kidney

The outer portion of the kidney is dark in colour and is called renal cortex and inner pale region of the kidney is called renal medulla. Renal medulla contains conical masses called renal pyramids. On the renal pyramids are found the openings called renal papillae, which open into the inner space of the kidney called renal pelvis. From the renal pelvis arises the ureter.

The kidneys are composed of millions of units called nephrons.

Structure of a nephron

Nephrons are the structural and functional units of the kidney, each kidney is composed of millions of nephrons. A nephron has two structural components namely, Malpighian capsule and the uriniferous tubules.

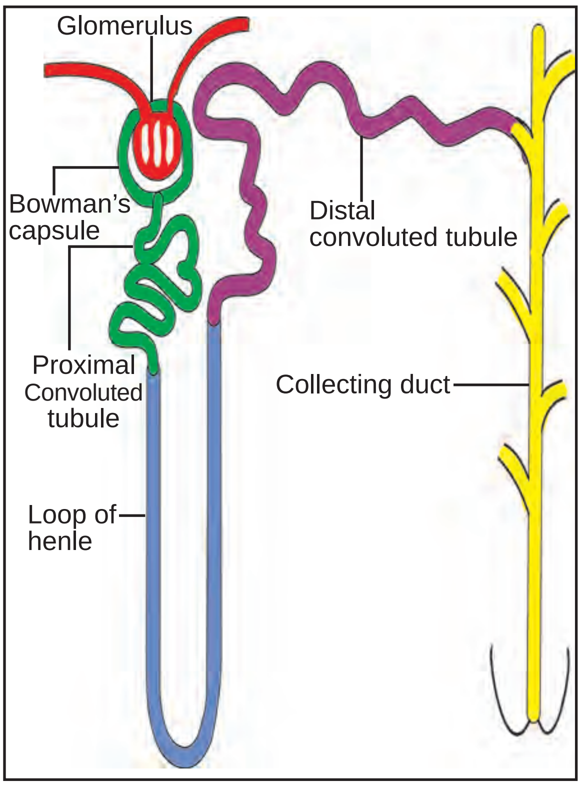


Fig. 5.8 Nephron

Malpighian capsule

This consists of a network of blood capillaries called glomerulus and a double walled cup called Bowman's cup. The glomerulus is a network of blood capillaries, formed by the branches of the wider afferent renal arteriole. From the glomerulus arises the narrow efferent renal arteriole, which branches over the rest of the nephron as network of capillaries. The Bowman's capsule accommodates the glomerulus.

Uriniferous tubules

From the Bowman's capsule arises the Uriniferous tubules. It is divided into three portions as the initial coiled proximal convoluted tubule, the middle U-shaped Henle's loop and the later coiled distal convoluted tubule. The distal convoluted tubule straightens as the collecting ducts. The collecting ducts open on the renal pyramids as renal papillae. The nephrons filter the blood and form the urine.

5.7. RELATIONSHIP OF STRUCTURE AND FUNCTION

Based on the functional need a particular organ or part gets a suitable modification in its structure. Thus a structure is so adapted to perform a specific function. So structure and function go hand in hand. The fore limbs of different mammals are suitably modified to do different functions according to their environment. For example, all the vertebrate animals in general, and all mammals in particular, have their fore limbs sharing a common basic pattern of construction. The fore limbs of mammals consist of five parts namely upper arm, fore arm, wrist, palm

and phalanges, but they are differently used in different animals like

i) Man uses his fore limb to hold an object, write, operate very fine musical instruments and delicate digital devices. The thumb is deviant from other four fingers, to enable man to do the above jobs.

ii) A horse uses it's fore limb to gallop.

iii) A rat or bandicoot uses it's fore limb to make holes in the ground to live.

iv) A giraffe uses its pretty long and stout fore limbs to reach up the vegetations, at the height of the plants.

v) A monkey leaps from one branch of the tree to another using it's fore limb to swing and leap.

vi) A whale uses its fore-limbs as oars to swim.

Fig. 5.9 Basic pattern of forelimbs of vertebrates

5.8. ANIMAL BEHAVIOR

Behaviour can be defined as an organism's adaptive response to stimuli in its environment. The stimuli may be as simple as the odour of the food. Nervous system perceives and passes the information concerning the environmental stimuli and trigger adaptive motor response which we see as the patterns of behaviour.

5.8.1. Social behavior

Behaviour is both an instinctive process (influenced by genes) and learned experience (gained by experience).

Social attachments between animals is called imprinting. The binding or attachment between the parents and the offspring is called filial imprinting. At times, we find an individual of a species is raised by a parent of another species (e.g the chick of cuckoo bird is fed by crow in its nest). This behavioural pattern is called cross fostering.

Many insects, fish, birds and mammals live in social groups in which information is communicated between group

Fig. 5.10 Honey Bee

members. For example some individuals in mammalian societies serve as guards.

In an elephant herd, it is always the oldest she elephant that leads the herd,

while the strong males will form the periphery of the herd and the young calves and other she elephants will be in the centre.

Sexual behavior

The coming closer of the opposite sexes is both by instinctive process and sexual attraction exhibited by one or both the partners. The secondary sexual characters developed during the breeding season bring the two sexes together for sexual reproduction. For example , the bright and colourful plumage of male peacock is to draw the attention of the female.

Sexual imprinting

Is a process in which an individual learns to direct its sexual behaviour at a member of its own species. During the courtship, animals produce signals to communicate with potential mates and with other members of their own sex. A character exhibited by one sex to attract the other sex is called courtship signalling. Many courtship signals are species, specific to help animals avoid making errors in mating.

Parental care

Any investment or effort by the parent to take care of the young ones in order to increase the chance of survival of the offspring and hence increase the reproductive success is called parental care. The parents care for the young ones and provide high nutrition, protect the young ones from predators and enable the young ones to lead a successful life.

Providing the young one with the milk from its mammary gland and aggression exhibited against the predator are the best means of taking care of the young one. Even after the nutritional independency is

Fig. 5.11 Parental care in elephants

obtained by the young one i.e it takes care of its nutrition by itself, the parental care is extended in some species beyond this level.

5.9. A CASE STUDY BY A RESEARCHER

The behavioural patterns in different situations are investigated in the research projects taken up by leading universities in Tamilnadu.

The abstract of case study by Arun Venkatraman, Asian Elephant Conservation Centre, Centre for Ecological Science, Indian Institute of Science – Bangalore on Dholes is given below.

Courtesy to the researcher – Mr.Arun Venkatraman)

Asiatic wild dog (Chen Nai – in Tamil), commonly called Dholes – ***Cuon***

alpines is an endangered species living in Mudumalai Wildlife Sanctuary at Nilgiris, Tamilnadu.

The Dholes live in packs which consist of old females, males, females and pups. The pack members co-ordinate while pulling down and killing large prey such as adult Sambar Deer. There is a tendency to share the meat among the members of the pack. However there prevails a squabbling among them to get the choicest meat. The young pups are allowed to take the meat first. The old males follow them. The other young ones and old females usually lag behind.

The Dholes also exhibit a high degree of parental care by changing the den frequently so that the pups are safe from predators such as leopards and hyenas.

Fig. 5.12 Dholes

ACTIVITY 5.3

CASE STUDY

- Conduct a case study on the behavioural aspects of your pet dogs in reference to their territorial dominance when strangers or other dogs try to enter into your locality.

ACTIVITY

- Follow an ant line and try to break its route by drawing a line with your finger without killing any ant.
- Observe the behaviour of the ants as to whether they change the route or go in disarray.
- Try to observe for a few minutes for any change they resort in their route. Make a report of their behaviour and submit.

- functions efficiently.
- Behaviour is the adaptive response of an organism to the stimuli in the environment.
- Social behaviour is both instinctive and learned experience.
- Sexual behaviour involves courtship signalling which is species specific.
- The investment or effort by the parent on their offsprings to provide nutritive food and safeguard them from predators is called parental care.

EVALUATION

PART A

1. Sensitive whiskers are found in _________.

   Bat, Elephant, Deer, Cat.

2. The tusks of elephants are modified ________.

3. Pick out an animal which has four chambered stomach _______.

   Elephant, Dolphin, Deer, Kangaroo.

4. Normal body temperature of man is __________.

   98.4 – 98.6°F, 96.6 – 96.8°F, 94.4 – 98.6°F, 98.4 – 99.6°F.

5. Mitral valve is found between __________.

   Right auricle and right ventricle, Left auricle and left ventricle,

   Right ventricle and pulmonary artery, Left ventricle and aorta.

PART B

6. One of the following groups contains a non mammalian animal. Pick up the group.

   a. dolphin, walrus, porcupine, rabbit, bat
   b. elephant, pig, horse, donkey, monkey
   c. antelope, deer, cow, buffalo, black buck
   d. dog, cat, crocodile, lion, tiger

7. The epidermis of mammals contains
   a. hair, bristle, quills
   b. hair, nail, claw
   c. hair, bristle, horn
   d. hair, nail, scale

8. Based on relationship, fill up:

   Whale: Baleen plates; Bat : _______

9. Fill in the blanks.

   Plasma : Fibrinogen ; RBC : Carrier of oxygen; WBC: ————————

10. Master chemists of our body are kidneys. Justify.

    a. kidneys acquire all chemicals taken in the body
    b. maintain the chemical composition of blood
    c. kidneys send out all chemicals taken in the body
    d. kidneys store the various chemicals taken in the body

11. Based on modifications make the pairs:

    incisor: tusk of elephant;

    _____________ : quills of porcupine.

FURTHER REFERENCE :

Books:

1. Biology - **RAVEN, Johnson** WCB Mc Graw - Hill
2. Biology - A Modern Introduction, B.S. Beckett, Second Edition Oxform University Press.

6. LIFE PROCESSES

How do you differentiate the living things and non-living things?

If we see a dog running

(or)

a cow chewing cud

(or)

a man shouting loudly on the street,

We know that these are living beings.

What if the dog or the cow or the man were asleep?

We would still think that they were alive, but how did we know that? We see them breathing and we know that they are alive.

What about plants?

How do we know that they are alive?

We see their green leaves and some kind of movements like the folding and unfolding of leaves, stages of growth as common evidences for being alive.

6.1. WHAT ARE LIFE PROCESSES?

The maintenance of living organisms must go on even at the conditions, when they are not physically active. Even when we sit idle and during sleeping, this maintenance job through cells functioning has to go on. The life process includes the activities performed by the different organs to maintain the body.

Some of the life processes in the living beings are described below:

Nutrition

The processes of obtaining energy through consumption of food.

Respiration

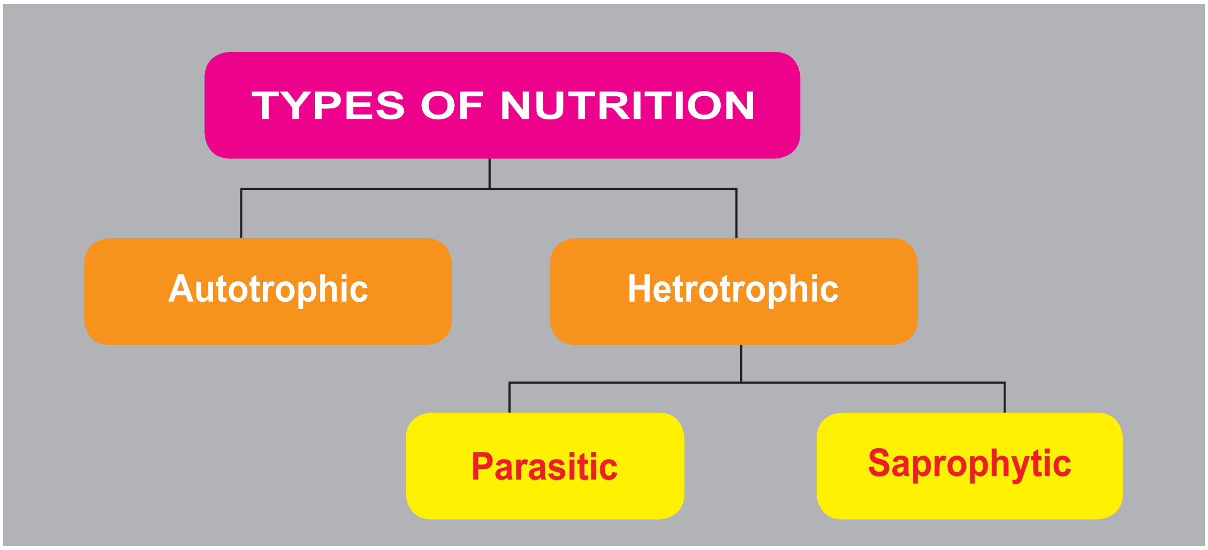
The process of acquiring oxygen through breathing and make it available to cells for the process of breaking down of organic substances into simpler compounds is called as respiration.

Transportation

Transportation is the process by which the food and oxygen is carried from one organ to other organs in the body.

Excretion

It is the process by which the metabolic waste by-products are removed from the different organs and released out from the body.



Questions

1. How do we understand the living nature of organisms?
2. What are the materials available from external sources for the organism's consumption?
3. What processes are essential to maintain our body?

6.2. NUTRITION IN PLANTS

Do you know that we need energy for all activities?

When do we get that energy?

The source of energy is the food we eat.

Types of Nutrition

Autotrophic Nutrition

Most of the green plants are self-dependent, because they synthesize their own food materials by photosynthesis. Such mode of nutrition is described as autotrophic nutrition.

It is the process by which autotrophic plants consume substances from the external sources and convert them into stored form of energy. The materials are taken in the form of carbon dioxide and water which are converted into carbohydrates in the presence of light and chlorophyll. Carbohydrates are utilized as energy rich sources to the plant., for their entire activity.

The process of photosynthesis is explained in the form of bio-chemical reaction shown below:

$$6CO_2 + 12\,H_2O \xrightarrow[\text{Sunlight}]{\text{Chlorophyll}} \underset{\text{(Glucose)}}{C_6H_{12}O_6} + 6O_2 + 6H_2O$$

The raw materials and other necessary items required for photosynthesis are Sunlight, Water, CO_2 and Chlorophyll.

Sunlight	-	energy from the sun
Water	-	plant absorbs water from the soil through roots.
CO_2	-	assimilated from the atmosphere through leaves containing small pores called stomata.
Chlorophyll	-	the green pigments in the chloroplasts, an organelle of the cells of leaf.

Let us do an activity which demonstrates that chlorophyll is essential for photosynthesis

ACTIVITY 6.1

1. Take a potted plant with variegated leaves – for example, money plant or crotons.
2. Keep the plant in a dark room for three days so that all the starch gets used up.
3. Now keep the plant in sunlight for about six hours.
4. Pluck a leaf from the plant. Mark the green areas in it and trace them on a sheet of paper.
5. Dip the leaf in boiling water for a few minutes.
6. After this, immerse it in a beaker containing alcohol.
7. Carefully place the beaker in a water-bath till the alcohol begins to boil.
8. What happens to the colour of the leaf? What is the colour of the solution?
9. Now dip the leaf in a dilute solution of iodine for few minutes.
10. Take out the leaf and rinse off the iodine solution.
11. Observe the colour of the leaf and compare this with the tracing of the leaf done in the beginning.
12. What can you conclude about the presence of starch in various spots of the leaf?

Heterotrophic nutrition

Fungal cells do not contain chloroplasts and they formed into saprophytes and parasites. Likewise all organisms, except the green plants do not possess chloroplasts as they do not carry out photosynthesis. They depend upon plants or other organisms for their nutrition.

Parasites

Some organisms live on other organisms for nourishments. They are called Parasites. The plants or animals in which the parasites live for nourishments are called hosts. Parasitic plants have some special roots, which penetrate the host plants and absorb food from the phloem, water and minerals from xylem. These roots are called haustoria. (e.g.: Cuscutta and Viscum).

Saprophytes

Some plants obtain nutrients from non-living organic matter. They are called saprophytes. Many fungi and bacteria are

saprophytes. Certain angiosperms like Monotropa lack chlorophyll and have mycorrhizal roots.The plant absorbs nourishments from the humus through their mycorrhizal roots.

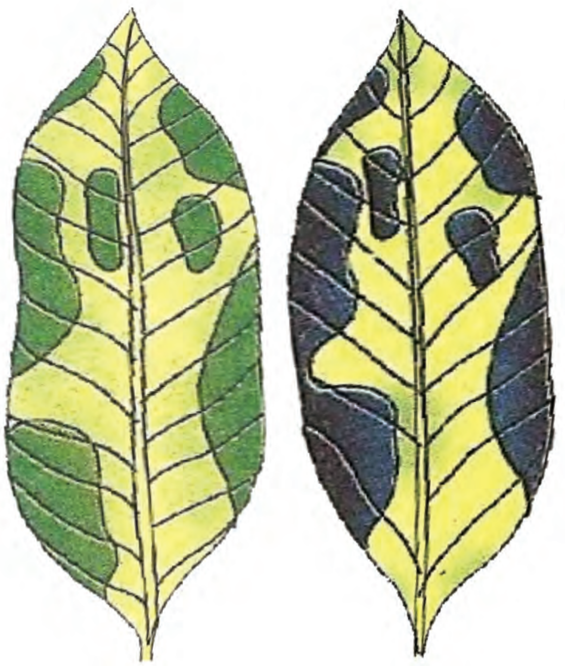


Fig. 6.1 Variegated Leaf

(a). Before starch test *(b). After starch test*

Fig. 6.2 Cuscutta - a parasitic plant

Fig. 6.3 Viscum - a parasitic plant

Questions

1. What are the differences between autotrophic nutrition and heterotrophic nutrition?
2. What are the sources of materials required by plants for photosynthesis?

6.2. HUMAN DIGESTIVE SYSTEM

Intracellular digestion

White blood cells (leucocytes) in vertebrate animals are defensive in functioning and get rid of germs in the body of the animals. WBCs engulf the invading germs by producing pseudopodia around the germs and digest the germs inside them by phagocytosis.

The unicellular animalcules like Amoeba also produce pseudopodia to engulf the diatoms and other minute organisms and digest them within the cell. Paramoecium, an another protozoan has a cytopharynx, a cytoplasmic depression to swallow the food (i.e microorganisms

in water) and digest the food within the cells. In the above mentioned examples the food is directly taken into the cells and is digested within the cell. This sort of digestion is called intracellular digestion. Intracellular digestion is a very primitive form of digestion and does not require an organized digestive system. Even in animals like sponges and coelenterates, the digestion is intracellular, though an alimentary canal like structure has developed in them.

Extracellular digestion

As animal body becomes more complex, digestive system has evolved to digest the food taken into the body. The digestive system in higher animal and man consists of alimentary canal and digestive glands that are specialized to produce digestive juices. Food is taken into alimentary canal and in the regions of digestion like mouth, stomach and duodenum, digestive juice is secreted by the digestive glands and the complex food swallowed is broken down to simpler food molecules by the action of enzymes of the digestive juices. Since digestion takes place in the space or lumen of alimentary canal i.e outside the cell it is called as extracellular digestion – an advanced form of digestion.

Digestion in human beings

Food contains a number of nutrient molecules needed for building up of new body tissues, repairing damaged tissues and sustained chemical reactions.

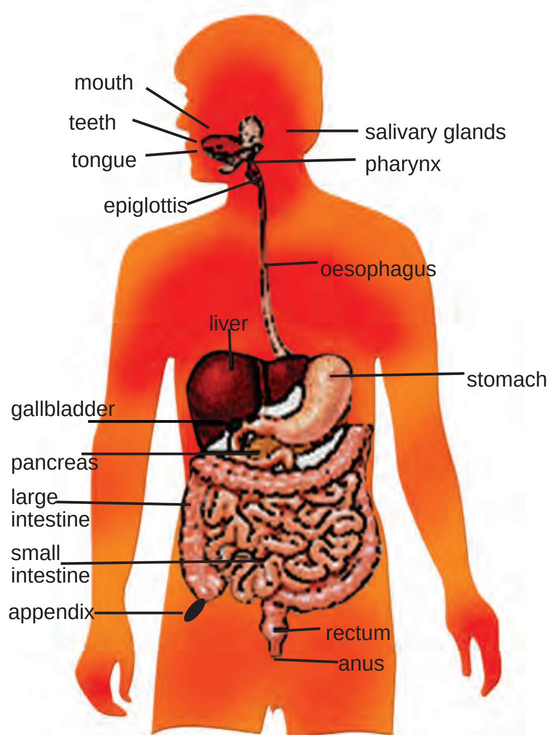


Fig. 6.4 Human Digestive System

ACTIVITY 6.2

- Take I ml of starch solution (1%) into test tubes (A and B)
- Add I ml of saliva to test tube A and leave both the test tubes undisturbed for 20-30 minutes
- Now add a few drops of dilute iodine to the test tubes
- In which test tube do you observe a colour change?
- What does this indicate about the presence or absence of starch in the two test tubes?
- What does this tell us about the action of saliva on starch?
- Is there a difference? If yes, in which case more energy from external sources is consumed.

Food must be broken down to be used as a source of energy. The process of converting the complex food into a simple chemical substance, that can be absorbed and assimilated by the body is called digestion. The medical speciality that deals with the structure, function, diagnosis and treatment of diseases of stomach and intestine is called gastroenterology.

The digestive system is composed of two groups of organs. They are

1) The gastro intestinal tract
2) Accessory digestive glands

Digestion is brought about in a stepwise manner with the help of enzymes which are otherwise called bio-catalysts.

The gastro intestinal tract (alimentary canal) is a long muscular tube, about 9 mts in length and it commences from the mouth and ends in the anus. The mouth, buccal cavity, pharynx, oesophagus, stomach, small intestine, large intestine, rectum and anus are the parts of the alimentary canal.

6.3. RESPIRATION IN PLANTS

Why should we eat?

Why should plants synthesize food?

For the simple reason that all living organisms ranging from minute bacteria to large elephants, plants and humans, require energy for growth, movement and reproduction.

Where does this energy come from?

Food that we eat is the starch that is synthesized by plants and it is the source of energy.

In fact, energy is locked up in food materials. During respiration, the food materials are oxidized (degraded). During this reaction, energy is released from the food and it is stored in a special chemical (or) biological substance called ATP (Adenosine triphosphate).

The energy of ATP is utilized in various activities of cells.

Apart from ATP, two other substances are also formed during respiration. They are CO_2 and H_2O.

$$\underset{\text{(Glucose)}}{C_6H_{12}O_6} + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \underset{\text{(ATP)}}{2900\text{KJ energy}}$$

Substance that is used in respiration is known as respiratory substrate. Respiratory substrates are of three kinds viz., carbohydrates, fats and proteins.

Types of Respiration

Depending on whether oxygen is used or not, respiration is of two types:

1. Aerobic respiration.
2. Anaerobic respiration.

1. Aerobic respiration

In majority of living organisms, oxygen is utilized during respiration. Respiration that uses oxygen is known as aerobic respiration.

Aerobic respiration takes place in four stages:

1. Glycolysis
2. Oxidative decarboxylation of pyruric acid
3. Kreb's cycle
4. Electron transport chain.

In Glycolysis, glucose (a simple carbohydrate) is split into two molecules of pyruvic acid. This takes place in the cytoplasm, in a series of reactions and a number of enzymes are involved. With the formation of pyruvic acid, glycolysis comes to an end.

Further oxidation of pyruvic acid takes place in the second and third stages occurring in the mitochondria.

During the last stage i.e. electron transport chain, the energy associated with the liberated electrons is used to synthesize the ATP energy molecules at certain stages. Finally the hydrogen, an electron joins with oxygen to produce water as a by-product.

Complete oxidation of a glucose molecule in aerobic respiration produces 38 ATP molecules.

2. Anaerobic respiration

In some organisms, oxygen is not utilized for respiration. This type of respiration is known as anaerobic respiration. It is also known as fermentation.

[E.g. Conversion of milk into curd.]

6.3. RESPIRATION IN ANIMALS

Amoeba, Hydra, Sponge, etc,. live in water. In these organisms, respiration takes place through their body surface. Dissolved oxygen in water diffuses through the cell membrane or body surface into

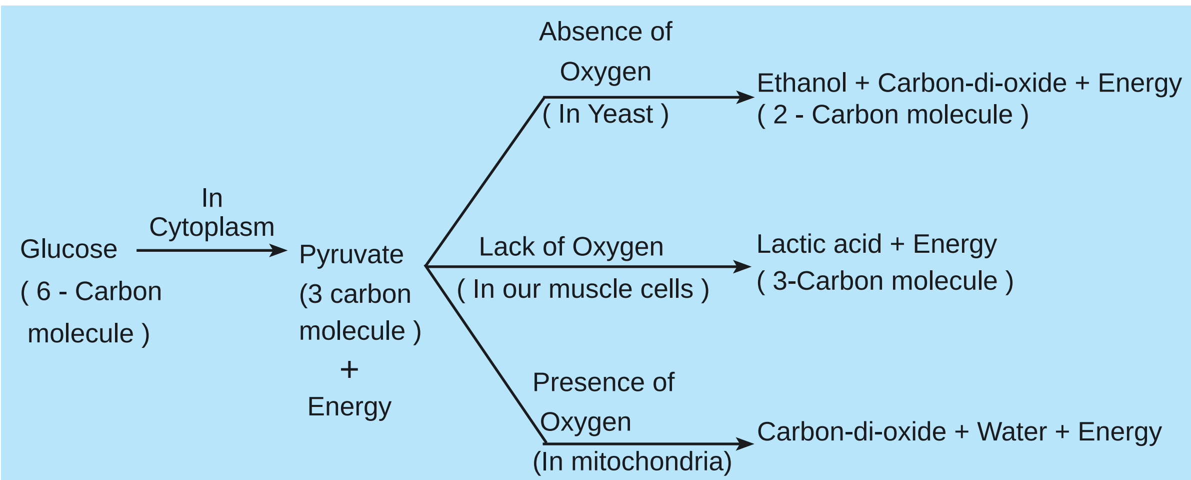


Fig. 6.5 Break down of glucose by various pathways

ACTIVITY 6.3

- Take some fruit juice or sugar solution and add some yeast to this. Take this mixture in a test tube fitted with a one-holed cork.
- Fit the cork with a bent glass tube. Dip the free end of the glass tube into the test tube containing freshly prepared lime water.
- What change is observed in the lime water and how long does it take for this change to occur?
- What does this tell us about the products of fermentation

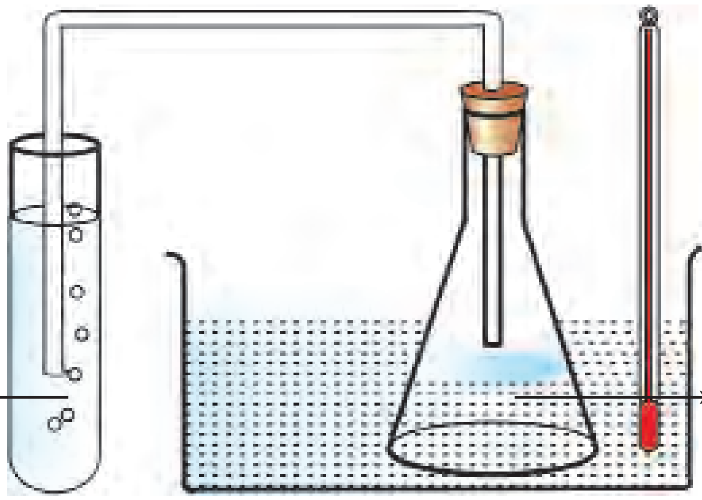


Fig 6.6 Anaerobic respiration apparatus

ATP

- ATP is the energy currency for the most cellular processes. The energy released during the process of respiration is used to make an ATP molecule from ADP and inorganic phosphate.
- ADP + Pi $\xrightarrow{\text{Energy}}$ ATP
- Think of how a battery can provide energy for many different kinds of uses. It can be used to obtain mechanical energy, light energy, electrical energy and so on. Similarly, ATP can be used in the cells for the contraction of muscles, protein synthesis, conduction of nervous impulses and many other activities.

the cell and after its usage, the carbon-di-oxide produced is passively diffuses out into water.

Repiratory surface for a fish is gill; for a frog it is lungs and skin the lungs for land vertebrates.

Since the amount of dissolved oxygen is fairly low, compared to the amount of oxygen in the air, the rate of breathing in aquatic organisms is much faster than that seen in terrestrial organisms. Fishes take in water through their mouth and force it past the gills where the dissolved oxygen is taken up by the blood.

Terrestrial organisms use the oxygen in the atmosphere for respiration, Oxygen is absorbed by different respiratory organs in different animals. All these organs have a structure that has bigger surface area, which is in contact with the oxygen-rich atmosphere. The exchange of oxygen and carbon-di-oxide has to take place across this surface. But it is usually placed within the body. So there are air passages present, that will take atmospheric air to this area. In addition, there is a mechanism for blowing the air in and out of this area where oxygen is absorbed.

In human beings, air is taken into the body through the nostrils. The air passing through the nostrils is filtered by fine hairs that line the passage. This passage is also lined with mucous which helps in this process. From here, the air passes through the throat into the lungs. Rings of cartilage are present in the throat which keep the air passage open and prevent it from collapsing.

Within the lungs, the air passage branches repeatedly into smaller tubules which finally terminate in balloon like structure called alveoli. The alveoli surrounded by blood capillaries provide a surface, where the exchange of gases takes place.

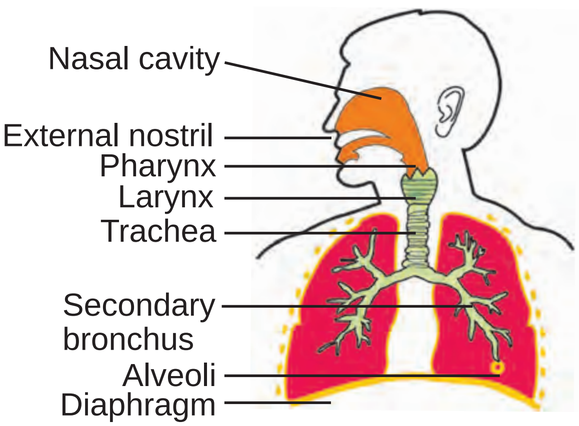


Fig. 6.7 Human respiratory system

ACTIVITY 6.4

- Observe fishes in an aquarium, and their opening and closing of mouth and the gill slits (or the operculum which covers the gill slits) found behind their eyes also open and close. Is not the timing of the openings and closings of the mouth and gill slits co-ordinated?
- Count the number of times the fish opens and closes its mouth in a minute.
- Compare this into the number of times you breathe in and out in a minute.

6.4. TRANSPORTATION IN PLANTS

We have discussed earlier, how the plants prepare food by the process of photosynthesis using various raw materials, like water, CO_2, sunlight and chlorophyll.

We already know that the chlorophyll pigments are in the leaf. So the leaf is the site for photosynthesis. The food prepared from the leaf should be transported to all other parts.

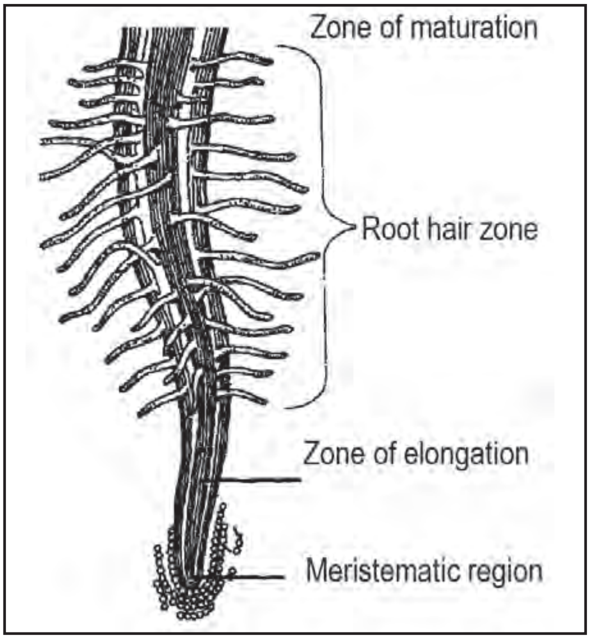


Fig. 6.8 Root hair region

In the same manner, water is essential for photosynthesis and all other biological activities in the plants. For plants, soil is the nearest and richest source of water and other raw materials like nitrogen, phosphorus and other minerals.

How do the absorbed water and minerals get transported from one place to all other parts of the plant body?

Which part of the plant is in contact with the soil?

For the above questions, you were getting answers already in your lower classes.

The roots are the absorbing organs of the plant.

Thus, plant transport systems will mobilize energy stores, (food) from leaves, and raw materials from roots. These two pathways are constructed as independently organized conducting tubes.

i) Xylem transports water with dissolved minerals absorbed from the soil.

ii) Phloem transports products of photosynthesis (food) from the leaves to the parts of the plant.

Transport of water

In xylem, vessels and tracheids are the conducting elements of the roots, stems and leaves. They are inter-connected to form a continuous system of water conducting channels, reaching all parts of the plant. In roots, the root hair cells in contact with the soil, actively take up ions.

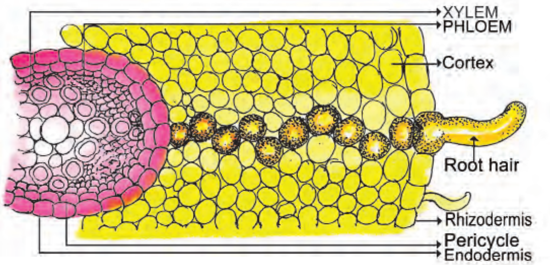


Fig. 6.9 Path of water across the root

This creates a difference in the concentration of these ions between the root and the soil. Water, therefore enters into the root from the soil to eliminate this difference.

This means that there is a steady movement of water into root xylem, creating a column of water that is steadily pushed upwards.

Is this pressure enough to conduct water over the heights in tall and huge trees?

Plants use another strategy to move water in the xylem upwards to the highest points of the plant body. This can be achieved by the process of transpiration, in which when the plant has an adequate supply of water. The water which is lost

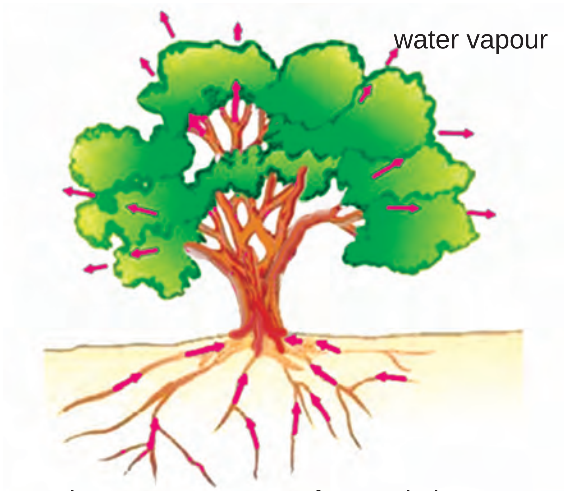


Fig. 6.10 Movement of water during transpiration in a tree

through the stomata is replaced by water from the xylem vessels in the leaf.

In fact, evaporation of water molecules from the cells of a leaf creates a suction which pulls water from the xylem cells of roots.

ACTIVITY 6.5

- Place a potted plant into a clear glass bell jar. The pot is covered with plastic to prevent water evaporating from the soil.
- Set up a second bell jar with a potted plant with leaves removed.
- Keep the bell jars in bright light at room temperature (20oC) for 6 hours.
- No liquid condenses in the bell jar without leaves.
- The bell jar containing the leafy plant has much more condensed liquid.
- Test the liquid it turns dry blue cobalt chloride paper to pink colour. Therefore the liquid is water.
- Discuss with your classmates, and find the reason why water droplets are formed in the potted plants containing leaves.

The loss of water in the form of vapour from the aerial parts of the plant is known as transpiration.

Thus, transpiration helps in the absorption and upward movement of water and mineral dissolved in it from roots to the leaves. It also helps in temperature regulation. The effect of root pressure in transport of water is more important at night. During the day when the stomata are open, the transpiration pull becomes the major driving force in the movement of water in the xylem.

Transport of food and other substances

How are the products of photosynthesis transported from leaves to other parts of the plant?

The transport of soluble products of photosynthesis is called translocation and it occurs in the part of the vascular tissue known as phloem. Besides the products of photosynthesis, the phloem transports amino acids and other substances. These substances are especially delivered to the storage organs of roots, fruits, seeds and to growing organs.The translocation of food and other substances takes place in the sieve tubes (sieve tubes are one of the constituents of the phloem which act as pipe line from leaves to the other parts of the plant) with the help of companion cells both in upward and downward directions.The translocation by phloem is achieved by utilizing energy. Materials like sucrose is transferred into phloem tissue using energy from ATP. This increases the osmotic pressure in the tissue causing water movement. This pressure moves the material in the phloem to tissues which have less pressure. This allows the phloem to move material according to the plant's needs. For example, in the spring, sugar stored in root or stem tissue would be transported to the buds, which need energy to grow.

Questions

1. What are the components of the transport system in highly organized plants?
2. How are water and minerals get transported in plants?
3. How is food transported in plants?

Transportation in animals

In microscopic organisms such as Amoeba and Paramecium, the volume of body is so small that useful substances can be distributed by a process called diffusion. Oxygen for example, enters an amoeba through the cell membrane and spreads out i.e diffuses, in all directions at the rate approximately equal to the rate at which oxygen is consumed in respiration. Similarly, carbon-di-oxide diffuses out of an Amoeba with sufficient speed to prevent it accumulating to harmful levels within the cell.

In large multi-cellular organisms, however, the body volume is so great that diffusion alone is far too slow a process for adequate distribution of oxygen and food, and removal of waste.

The cells in the multi-cellular organisms relying on diffusion alone would be a tightly packed crowd. Those in the middle region would not get enough oxygen. Hence, most large organisms do not rely on diffusion for their supply of food and oxygen. They have a transport system of some kind to carry these substances to all the cells in the body.

In human body, for example the transport system consists of a pump called heart which propels the fluid called blood around a complex system of tubes called blood vessels. As it passes through these blood vessels, the blood picks up oxygen from the lungs and transport it to every cell in the body. Blood also picks up waste product such as carbon-dioxide and many other substances like salts from the cells and excrete out from the body.

Lymph

There is another type of fluid which is also involved in transportation. This is called lymph or tissue fluid. It is similar to the plasma of blood but it is colourless and contains less protein. Lymph drains into lymphatic capillaries from the intercellular spaces, which join to form large lymph vessels that finally open into veins. Lymph carries digested and absorbed fat, from intestine and drains excess fluid from extra cellular space back into the blood.

ACTIVITY 6.6

1. Visit a health centre in your locality and find out what is the normal range of haemoglobin content in human beings.
2. Is it the same for children, women and men? Discuss why does the difference exist?

6.5. EXCRETION IN PLANTS

What is excretion?

How does the excretion take place in plants?

Excretion is the process by which the metabolic waste products are removed from the plant body.

In plants there are different ways for excretion.

1. Plant waste products are stored in cellular vacuoles.
2. Waste products may be stored in leaves that fall off.
3. Other waste products are stored as resins and gums, especially in old xylem tissues.
4. Plants also excrete some waste substances into the soil around them.

Excretion in animals

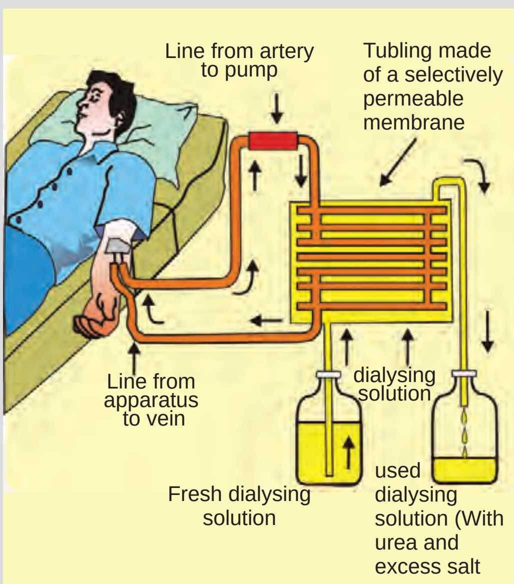
In unicellular protozoans, the excreta are discharged out through the contractile-vacuoles, which are formed by the absorption of water and other excreta.

In coelenterates and sponges, the excreta diffuse out through the cell membrane.

In flat worms and round worms, the excretory tubes develop for transporting

Artificial kidney (Hemodialysis)

Kidneys are vital organs for survival. Several factors like infections, injury or restricted blood flow to kidneys reduce the activity of kidneys, This leads to accumulation of poisonous wastes in the body, which can even lead to death. In case of kidney failure, an artificial kidney can be used. An artificial kidney is a device to remove nitrogenous waste products from the blood through dialysis.



Artificial kidneys contain a number of tubes with a semipermeable lining, suspended in a tank filled with dialysing fluid. This fluid has the same osmotic pressure as blood, except that it is devoid of nitrogenous wastes. The patient's blood is passed through these tubes. During this passage, the waste products from the blood pass into dialysing fiuid by diffusion. The purified blood is pumped back in to the patient. This is similar to the function of the kidney, but it is different since there is no re- absorption involved. Normally, in a healthy adult, the initial filtrate in the kidneys is about 180 L daily. However, the volume actually excreted is only a litre or two a day, because the remaining filtrate is re- absorbed in the kidney tubules.

the excreta to exterior. In annelids special kidneys called nephridia are evolved to collect excreta from the coelomic cavity.

In vertebrates, an elaborate well-defined excretory system has developed with kidneys and excretory tubes. The kidney of vertebrates consists of nephrons which filter the blood and form the urine and large amount of ammonia is found in fish excreta. They are called ammoniatelic animals. The birds are called uricotelic animals as their excretory substance is composed mostly of uric acids.In mammals urea is the main excretory products so they are called ureotelic animals.

Nephron

Each Nephron consists of a filtering apparatus called glomerulus and uriniferous tubules.The glomerulus filters the plasma part of the blood to form urine. The uriniferous tubules reabsorb the substances required in the body from that filterate and the final urine product contains mostly water and nitrogenous waste products.

6.6. NERVOUS SYSTEM

The millions of cells and the scores of different tissues and organs in the body of an animal do not work independently of each other. Their activities are co-ordinated. This means that they work together, performing the various functions at certain times and at certain rates according to the needs of the body as a whole.

One of the most familiar examples of co-ordination is the way in which muscles works together during movement. When a boy runs to catch a ball, for example, he uses hundreds of muscles to move the joints in his arms, legs and back using informations from his sense organs. The boy's nervous system co-ordinates these muscles so that they contract in correct sequence with the correct degree of power, and for precisely the correct length of time needed to get him to the spot where he can catch the ball. Muscular activities like running to catch a ball, involves many other forms of co-ordination, such as those which increase the rate of breathing and heart beat to adjust blood pressure, remove extra heat from body and maintaining sugar and salt levels in the blood. Furthermore, all these co-ordinations occur as an unconscious process.

Worms have the simplest form of coordinating system where an earthworm has dual nerve cords. Two ganglia acts as brain and eye spots act as photo receptors.

In insects, ganglia are connected by a ventral nerve cord function as brain. Well-developed sensory organ for vision and antennae for olfactory function are present.

In mammals and other well-developed vertebrates this co-ordination is achieved by nervous system and endocrine system.

In simple, the nervous system consists of tissues which conducts “messages” called nerve impulses, at a high speed to and from all parts of the body.

6.7. CO-ORDINATION IN PLANTS

How do plants co-ordinate?

Unlike animals, plants have neither nervous systems nor muscles.

Fig. 6.11 Sensitive Plant (Touch-me-not plant)

So, how do they respond to stimuli?

When we touch the leaves of Touch–me–not plant, they begin to fold up and droop.

When a seed germinates, the roots go down , the stem comes up above the soil.

What happens during the above actions?

In the first instance, the leaves of sensitive

Plants show two different types of movements.

1. Movement independent of growth
2. Movement dependent on growth

Movement- Independent of growth

Immediate response to stimulus

This movement is sensitive to plant. Here, no grow th is involved but, the plant actually moves its leaves in response to touch. But there is neither nervous tissue nor muscle tissue.

How does the plant detect the touch and how do the leaves move in response?

In touch-me-not plant, if we touch at one point, all the leaflets show the folding movements. This indicates that the stimulus at one point is communicated. But unlike in animal, there is no specialized tissue in plants for transmitting the information. Plant cells change the shape by changing the amount of water in them resulting in swelling or shrinking and therefore the leaves in touch-me-not plant shrinks.

Movement dependent on growth:

More commonly, the plants respond to stimuli slowly by growing in a particular direction. Because this growth is directional, it appears as if the plant is moving.

Let us understand this type of movement with the help of some examples.

1. Response of the plant to the direction of light (Phototropism)
2. Response of the plant to the direction of gravitational force (Geotropism)

ACTIVITY 6.7

1. Go to the field and find the touch-me-not plant.
2. Touch the plant at one point.
3. Observe what happens.

3. Response to the direction of water (Hydrotropism)
4. Response to the direction of chemicals (Chemotropism)

Phototropism

It is the growth of the stem towards the direction of sunlight.

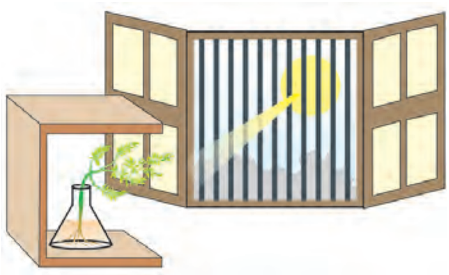


Fig. 6.12 Phototropism

Geotropism

It is the growth of roots towards the direction of gravitational force.

Roots cannot grow towards sunlight and stem cannot grow towards gravitational force.

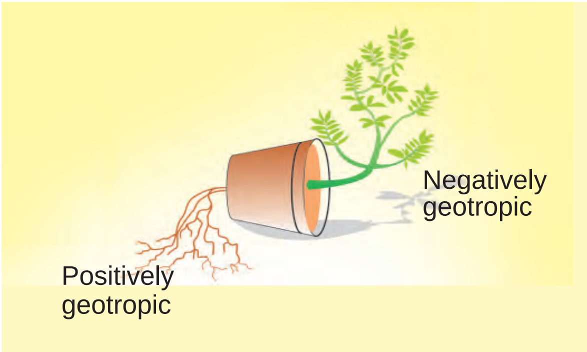


Fig 6.13 Geotropism

Hydrotropism

The roots of very huge trees grow towards the availability of water source

(e.g) The roots of coconut tree are seen away from the plant for the want of water.

Chemotropism

This is the movement of plant parts towards the direction of chemicals. (e.g) The pollen tubes grow towards ovule.

ACTIVITY 6.8

- Fill a conical flask with water.
- Cover the neck of the flask with a wire mesh.
- Keep two or three freshly germinated bean seeds on the wire mesh.
- Take a cardboard box which is open from the side.
- Keep the flask in the box in such a manner that the open side of the box faces light, coming from a window.
- After two or three days, you will notice that the shoots bend towards light and roots away from light.
- Now turn the flask so that shoots are away from the light and roots towards light. Leave it undisturbed in this condition for a few days.
- Have the old parts of the shoot and root changed direction?
- Are there differences in the direction of the new growth?
- What do you understand from this activity?

6.9. HORMONES IN ANIMALS

The endocrine system consists of ductless glands and their secretions called hormones. Hormones are bio - chemical substances which act as bio catalysts speeding up the chemical reactions. These are released into the blood stream and transported around the body. Harmones co-ordinate the physiological activities in our body. A detailed account on hormones is dealt in chapter 3.

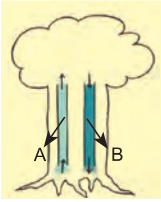
EVALUATION

PART A

1. In monotropa the special type of root which absorbs nourishment is (Haustoria, Mycorrhizal root, Clinging root, Adventious root)
2. The product obtained in the Anaerobic respiration of yeast is (Lactic acid, Pyruvic acid, Ethanol, Acetic acid)
3. The roots of coconut tree are seen away from the plant. Such kind of movement of root for want of water is (Phototropism,Geotropism,Chemo-tropism, Hydrotropism)
4. The xylem in the plants are responsible for (transport of water, transport of food, transport of amino acid, transport of oxygen)
5. The autrotropic nutrition requires (CO_2 and water, chlorophyll, sunlight, all the above)

PART B

6. Name the types of vascular tissues in the plant stem which are labelled as A and B

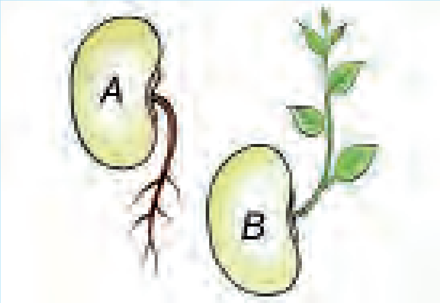


a) Name A and B

b) What are the materials transported through A?

c) What are the materials transported through B?

d) How do the materials in A move upwards to leaves?



7. Observe the above diagram

a) Mention the type of movements shown in fig, A and B.

b) How does the movement differ from the movement of mimosa

8. Match the methods of nutrition of special organs with suitable examples.

Autotrophs	Mycorrhiza	Cuscutta
Parasites	chlorophyll	Monotropa
Saprophytes	Haustoria	Hibiscus

9. In the process of respiration_____ is carbon compound, the lactic is _____ carbon compound.

10. Sugar is converted into alcohol. From the above statement what kind of process takes place? Which micro organism is involved?

11. Pick out the odd one : The parts of the alimentary canal are (Pharynx, mouth, buccal cavity, pancreas)

12. In human beings air enters into the body through _________ and moves into __________ In fishes water enters into the body through _________ and the dissolved oxygen of water diffuses into _________.

PART C

13. Compare the respiration in higher plants with the respiration in lower plants

14. Is the pressure created in xylem enough to conduct water in tall trees. Give reasons.

15. In touch me not plant the leaves show movements. What type of movement have you observed. Discuss.

NAME OF THE PLANTS IN ENGLISH & TAMIL

SL. NO.	BOTANICAL NAME	NAME IN ENGLISH	TAMIL NAME	HOW IT IS CALLED LOCALLY
1	MONOTROPA UNIFLORA	INDIAN PIPE	மானோடிரோபா	
2	VISCUM	PARASITIC PLANT	புல்லுருவி	
3	CUSCUTA REFLEXA	PODDERPLANT	அம்மையார் கூந்தல் /சடதாரி	

FURTHER REFERENCE

Books : 1. Modern Plant Physiology **Sinha Narosa**

2. Fundamentals of plant physiology **Jain .V.K**.

Chapter 7

CONSERVATION OF ENVIRONMENT

7. Conservation of Environment

Living organisms live in different surroundings. Some plants and animals completely live in water and some others live on land.

Man also leads life in different surroundings. Some live in cities, some in towns and some in villages. How do they adapt themselves to the place they live in?

Plants, animals, human beings survive with the interaction between them and the non-living things like air, water and land. Human beings depend on the resources of nature. These resources include soil, water, coal, electricity, oil, gas, etc. These resources improve the life style of human beings.

Environmental science can be defined as the study of organisms in relation to their surrounding.

In the course of development, unplanned and vast misuse of natural resources like water, forest produce, land and mineral resources have occurred. This has led to an imbalance in nature and release of many harmful substances in the atmosphere.

Mankind is greatly influenced by the surrounding in view of the problem of over Population, environmental pollution, human survival, pest control and conservation of natural resources.

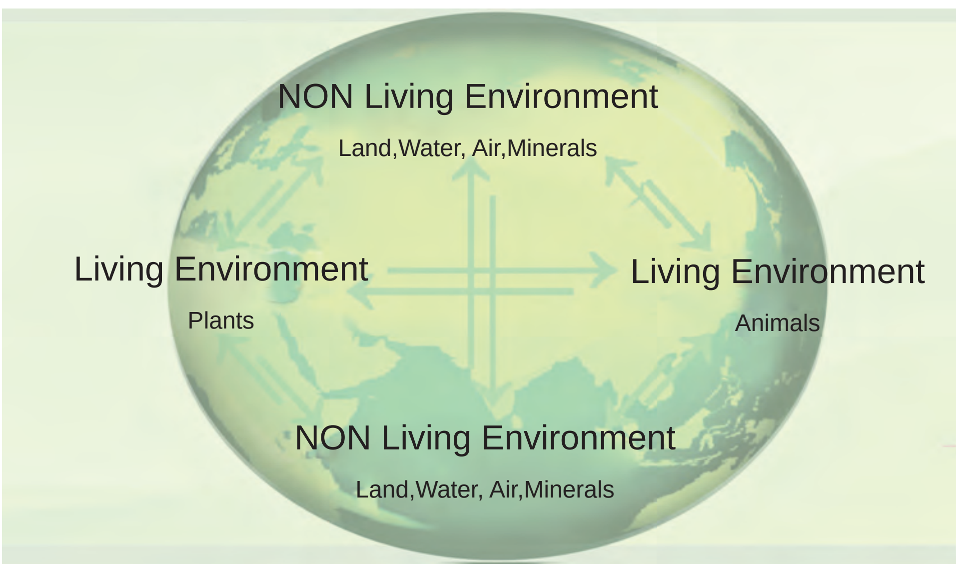


Fig. 7.1 Interaction between non-living and living components in the biosphere

In our daily activities, we generate a lot of materials that we throw away.

- What are some of these waste materials?
- What happens after we throw them away?

Human activities related to livelihood and welfare generate waste. All wastes are pollutants and they create pollution in one way or another. Air, land and water surroundings are affected due to improper disposal of wastes which create an imbalance in the environment.

- What is Pollution?
- What are Pollutants?

Pollution: Any undesirable change in the physical, chemical or biological characteristics of air, land and water that affect human life adversely is called pollution.

Pollutant: A substance released into the environment due to natural or human activity which affects adversely the environment is called pollutant. e.g. Sulphur-di-oxide, carbon-monoxide, lead, mercury, etc.

7.1.CLASSIFICATION OF WASTES

1. Bio–degradable wastes
2. Non–bio-degradable wastes

Substances that are broken down by biological process of biological or microbial action are called bio-degradable waste. e.g. wood, paper and leather.

Substances that are not broken down by biological or microbial action are called non-bio-degradable wastes. e.g. Plastic substances and mineral wastes.

How to protect us from these hazardous wastes ?

Why do the government and so many organizations conduct awareness

ACTIVITY 7.1

- Find out what happens to the waste generated at home. Is there a system in place to collect this waste?
- Find out how the local body (panchayat, municipal corporation or resident welfare association) deals with the waste. Are there mechanisms in place to treat the bio-degradable and non-bio-degradable wastes separately? Calculate how much waste is generated at home in a day.
- How much of this waste is bio-degradable?
- Calculate how much waste is generated in the class room in a day.
- How much of this waste is non bio-degradable?
- Suggest ways of dealing with this waste

THINK IT OVER

Disposable cups in trains

If you ask your parents, they will probably remember a time when tea in trains was served in plastic tumblers which had to be returned to the vendor. The introduction of disposable cups was hailed as a step forward for reasons of hygiene. No one at that time probably thought about the impact caused by the disposal of millions of these cups on a daily basis. Some time back, Kulhads, that is, disposable cups made of clay, were suggested as an alternative. But a little thought showed that making these Kulhads on a large scale would result in the loss of the fertile top-soil. Now disposable paper-cups are being used. What do you think are the advantages of disposable paper-cups over disposable plastic cups?

Progarmmes against using plastics ?

The following methods are adopted for the disposal of harmful waste materials.

1. Land Fills

There are permanent storage facilities in secured lands for military related liquid and radioactive waste materials. High level radioactive wastes are stored in deep underground storage.

2. Deep well injection

It involves drilling a well into dry porous material below ground water. Hazardous waste liquids are pumped into the well. They are soaked into the porous material and made to remain isolated indefinitely.

3. Incineration

The burning of materials is called incineration.

Hazardous bio-medical wastes are usually disposed off by means of incineration. Human anatomical wastes, discarded medicines, toxic drugs, blood, pus, animal wastes, microbiological and bio-technological wastes etc., are called bio-medical wastes.

Management of non-hazardous wastes – solid waste management

Reuse and recycling technique

The separating out of materials such as rubber, glass, paper and scrap metal from refuse and reprocessing them for reuse is named as reclamation of waste or recycling.

Paper

(54% recovery) Can be repulped and reprocessed into recycled paper, cardboard and other products.

Glass

(20% recovery) Can be crushed, re-melted and made into new containers or crushes used as a substitute for gravel or sand in construction materials such as concrete and asphalt, Food waste and yard wastes (leaves, grass etc.,) can be composted to produce humus soil conditioner.

7.2. WATER MANAGEMENT

Due to increasing demands for water and reduced availability of fresh ground water resources, urgent measures have to be taken to conserve each and every drop of water that is available.

Clean and fresh water is essential for nearly every human activity. Perhaps more than any other environmental factors, the availability of water determines the location and activities of human beings.

Can you list out the reasons for increasing demand of water?

7.2.1. Sources of water

Water is a basic natural resource and valuable asset to all nations. Human beings depend on water for all their needs such as bathing, washing, cooking, transportation and power. Water in India is of two kinds. Salt water and fresh water. Fresh water is obtained from rain water, surface water and ground water.

The main sources of water are rain and snow which form a part of the hydrological cycle.

Surface water

India is blessed with a number of rivers, lakes, streams and ponds.

Ground water

Aquifers are under ground reserves of fresh water.

In the water table, water that percolates into the ground through porous rocks is ground water. These porous rocks are saturated with water to a certain level. The upper layer of waterlevel is the watertable. The ground water is important for plant growth, man also taps this water through tube wells and bore wells. Scanty rainfall and unnecessary felling of trees affect the ground water level.

7.2.2. Fresh water management

To meet out the water scarcity we need several ways to increase the water supply.

i) Seeding clouds

Seeding clouds with dry ice or potassium iodide particles sometimes can initiate rain if water laden clouds and conditions that favour precipitation are present.

ii) Desalination: (Reverse osmosis)

Desalination of ocean water is a technology that has great potential for increasing fresh water. Desalination is more expensive than most other sources of fresh water. In desalination, the common methods of evaporation and re-condensation are involved.

iii) Dams, reservoirs and canals

Dams and storage reservoirs tap run-off water in them and transfer the water from of excess to areas of deficit using canals and underground pipes.

iv) Water shed management

The management of rainfall and resultant run-off is called water shed management. Water shed is an area characterized by construction of small dams to hold back water which will provide useful wildlife habitat and stock watering facilities.

v) Rain water harvesting

Rain water harvesting essentially means collecting rain water from the roof of building or courtyards and storing it under ground for later use. The main idea in harvesting rain water is to check the run-off water. The rain water that falls on the roofs of buildings or in courtyards is collected through pipes and stored in under ground tanks of the buildings fitted with motor for

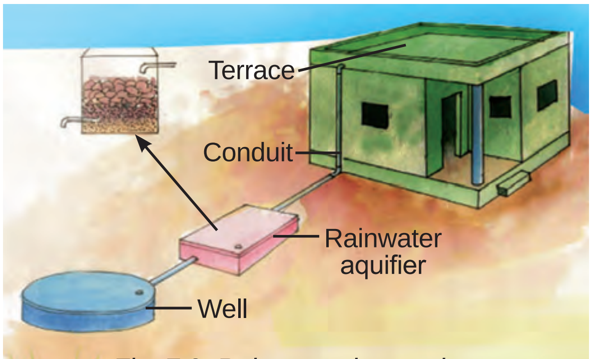


Fig. 7.2 Rain water harvesting

lifting water for use. The process of rain water harvesting is not only simple but also economically beneficial. It helps in meeting the increased demand for water, particularly in urban areas and prevent flooding of living areas.

vi) Wetland conservation

It preserves natural water storage and acts as aquifer recharge zones.

vii) Domestic conservation

As an individual, every one can reduce the water loss by taking shower, using low-flow taps, using recycled water for lawns, home gardens, vehicle washing and using water conserving appliances.

viii) Industrial conservation

Cooling water can be recharged and waste water can be treated and reused.

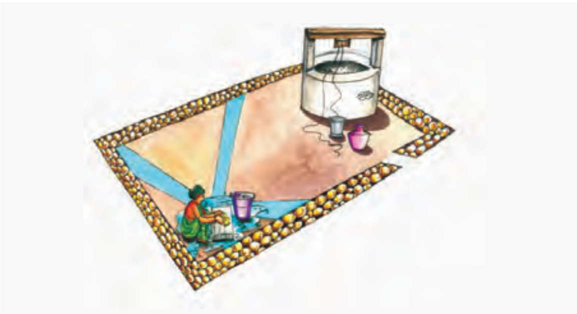


Fig. 7.3 Domestic conservation method of water

7.3. WILDLIFE SANCTUARIES

Wildlife

All non-domesticated and non-cultivated biota found in natural habitat are termed 'wildlife'. It includes all the natural flora and fauna of a geographic region. Wildlife is an asset to be protected and preserved to our own advantage and to the benefit of future generations.

There are approximately 400 varieties of reptiles, 200 varieties of amphibians, 3000 varieties of fishes, 3000 species of birds 20,000 species of flowering plants and 4100 species of mammals found in our country according to the latest census estimate.

It is essential to protect and conserve wildlife because they have aesthetic, ecological, educational, historical and scientific values, a good biotic diversity is essential for ecological balance. Large scale destruction of wildlife could lead to ecological imbalance. Wildlife also adds aesthetic value and from this, eco-tourism is being promoted in a big way by several countries. Wildlife and their products could be of great economic value if utilized properly. The invulnerable plants could yield products of immense medicinal value in future. Wildlife also forms as store of vast genetic diversity which could be properly used with advances in genetic engineering. Thus wildlife has been of great value in the past and will continue to be so in the future. Protection and conservation of wildlife, therefore gains importance.

SANCTUARIES

Wildlife sanctuary is an area constituted by competent authority in which hunting or capturing of animals is prohibited except by or under control of the highest authority responsible for management of the area.

Wildlife sanctuaries were established in India in the pursuit of conserving wildlife which was suffering due to ecological imbalance caused by human activities. There are 89 National parks, 500 wildlife sanctuaries, 27 Tiger reserves, 200 Zoos and 13 Biosphere reserves in the country covering an area of 1.6 lakh sq.km.

7.4. BALANCE IN ECOSYSTEM

What is Ecosystem?

- Fish lives in Water.
- Tiger lives in Forest.

Important sanctuaries in Tamilnadu

Name	Location	Animals
Indira Gandhi Wildlife, Sanctuary	Western Ghats.	Tiger, leopard, porcupine, nilgiris tahr, civet cat, elephant, gaur, pangolin.
Kalakkadu Wildlife Sanctuary.	Tirunelveli District	Lion tailed macaque, sambhar, sloth bear, gaur, flying squirrel.
Srivilipathur Grizzled squirrel wildlife Sanctuary	Virudhunagar District	Grizzled squirrels, mouse deer, barking deer, tree shrew.
Vedathangal Bird's Sanctuaries	Kancheepuram District	Cormorants, egrets, grey heron, open-billed stork, white bears, shovellers, pintails, stets, sandpipers.
Mudumalai wildlife Sanctuary	The Nilgiris	Elephants, gaur, langur, tigers, leopards, sloth bear, sambhar, wildbear, jackal, porcupine, mangoose.
Viralimalai	Trichy District	Wild peacocks
Gulf of Mannar marine National Park.	Coast of Rammad and Tuticorin district.	Coral reefs, dugong, tuties, dolphins, balanoglossus,
Mundhanthurai wildlife Sanctuary.	Tirunelvelli District	Tiger, bonnet macaque, langurs, sloth bear, wild dog.
Vallanudu Blackbuck Sanctuary.	Tuticorin District	Blackbuck, jungle cat, hare, mongoose.
Arignar Anna Zoological Park	Vandalur	Lion, elephant, tiger, monkeys.
Mukkurthi National Park	The Nilgiris	Tigers.
Point calimere wildlife Sanctuary	Nagapattinam district	Chital, wild bear, plovers, stilts, bonnet macaque.
Anamalai wildlife sanctuary	Slopes of western ghats.	Civet cat, porcupine, gaur, tiger leopard, nilgiri tahr.

Important National Parks, wildlife sanctuaries and reserves.

Bandhipur National Park (It is a tiger reserve too)	Karnataka	Indian bison, chital, sloth bear, elephants.
Corbett National Park (India's first national park) (Tiger reserve too)	Uttaranchal	Tigers, chital, elephants, leopard, Jungle cat and sloth bear.
Gir National Park	Gujarat	Aslatic Lion
Kanha National Park (Tiger reserve)	Madhyapradesh	Deer Tiger, Wilddog, chital.
Bharathpur Bird sanctuary	Rajasthan	374 special of bird, e.g. Indian darters, spoonbills, painted stock, open billed stork, black necked stork etc,.
Manas wildlife sanctuary (Tiger reserve)	Assam	Hispid hare (rere), pygmy hog, golden langue
Sunderbans National Park (Tiger reserve)	West Bengal	Unique Royal Bengal Tigers.

How can they lead their life in the above habitats?

A community of organisms that interact with one another and with the environment is called an ecosystem.

The Ecosystem is of two types, namely aquatic and terrestrial.

What are the major components in Ecosystem?

There are four major components, namely:

1. Abiotic factors
2. Producers
3. Consumers
4. Decomposers.

Producers, consumers and decomposers are biotic factors.

Pond Ecosystem

An example for aquatic ecosystem is a pond.

Abiotic factors

It includes light, temperature, hydrogen ion concentration, inorganic substances like CO_2, H_2, O_2, N, PO_4, CO_3 and S and organic substances like carbohydrates, proteins and lipids.

Biotic factors

It includes producers and consumers. Producers are the water living plants like *Hydrilla, Vallisneria* etc., and *phytoplankton* like *Chlamydomonas, Volvox* and *Spirogyra.*

Primary consumers or herbivores

Zooplanktons like insects, larvae of Dragon-fly consume the phytoplanktons.

Secondary Consumers

These are certain fishes, frogs, water beetles etc., which feed on the primary consumers in the pond.

Tertiary Consumers

These are big fishes and kingfisher that feed on small fishes.

Decomposers

Several bacteria and fungi form the decomposers in the pond.

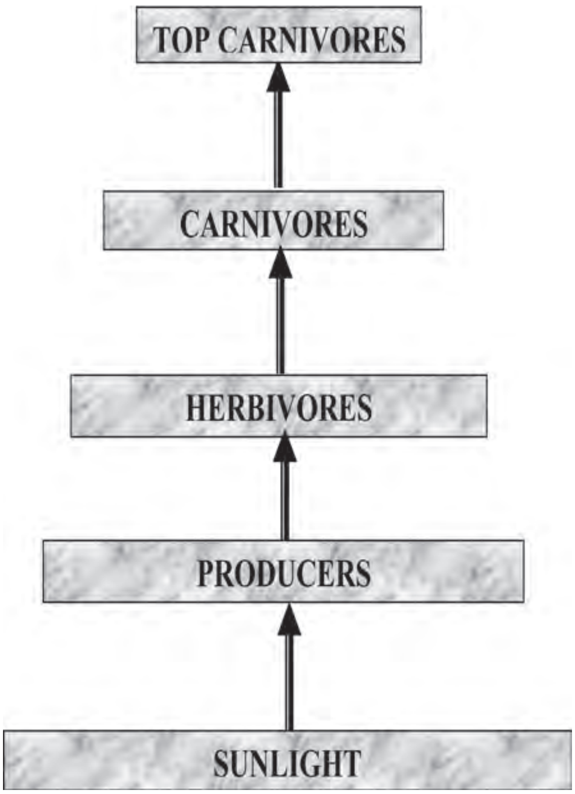


Fig. 7.4 Flow of energy in an ecosystem

BALANCE IN ECO-SYSTEM

A balanced ecosystem is an ecological community together with its environment and functioning as a complex unit.

ACTIVITY 7.2

- While creating an aquarium did you take care not to put an aquatic animal which would eat others? What would happen otherwise?
- Make groups and discuss how each of the above groups of organisms are dependent on each other.
- Write the aquatic organisms in order of who eats whom and form a chain of at least three steps.
- Would you consider any one group of organisms to be of primary importance? Why or why not?

An ecosystem is maintained by the balance in nature such as the balance between hawks and mice, if hawk population is larger than the mice population, then it is not balanced.

They are balanced between resources like a banana tree and monkeys. If the banana trees stop growing, the monkeys won't get bananas.

An ecosystem maintains the balance between the number of resources and the number of users or the balance between prey and predators.

What is food chain and food web?

Various organisms are linked by food chains in which the food energy is passed from one organism to another in a linear fashion.

e.g. Food chain of a grassland ecosystem.

Grass → Grass hopper → Frog → Snake→Eagle
(Producers) (Herbivores) (Primary consumer) (Secondar consumer) (Teritary consumer)

Fig. 7.5 Grassland ecosystem

ACTIVITY 7.3

- Go to a pond and observe the organisms that lives in the pond.
- List out the organisms.
- Prepare a chart of food chains

Food Web

The food chains are interlinked to form food webs, So every component of the ecosystem is connected to one another.

How is the ecosystem maintained?

There are many factors which maintain the harmony in an ecosystem naturally. Disturbing any one factor could have a drastic impact upon the living conditions of other organisms that will result in an imbalance. For example, removal of trees and vegetation would affect both land and water ecosystems as there will be no food for organisms. Killing animals and polluting land, air and water also disturb the balance in nature.

Inorder to maintain the eco-balance in an ecosystem, there should be recycling of nutrients, minerals, and water. Careful use of natural resources will maintain the eco-balance. Thus eco-balance or ecological balance is the maintenance of

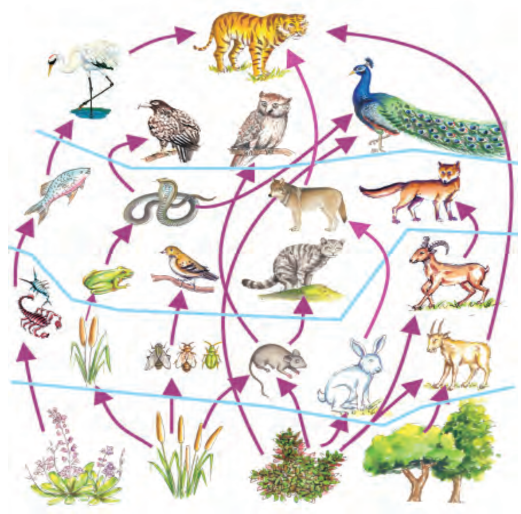


Fig. 7.6 Food web

balance between living components and its resources of an ecosystem, so that it remains a stable environment community for the better functioning of the organisms.

Bio - Geo chemical cycles

In an ecosystem, the energy from the sun is fixed by the plants. Then it is transferred to herbivores and carnivores. i.e. the energy flows in one direction only. But the minerals required in the ecosystem are continuously absorbed by the plants and transferred to animals. As the minerals are removed from the soil, they have to be replaced or cycled. These minerals are returned to the soil by the decomposition of dead and decaying materials by saprophytic organisms such as bacteria and fungi (You have studied the cycles in earlier classes in detail.)

7.5. COAL AND PETROLEUM

7.5.1 Coal

Coal is a compost primarily of carbon along with variable quantities of other elements chiefly sulphur, hydrogen, oxygen and nitrogen.

Coal is a fossil fuel and is the largest source of energy for the generation of electricity world wide, as well as one of the largest worldwide sources of CO_2 emissions. Gross CO_2 emission from coal usage is high and more than those from petroleum and about double the amount from natural gas.

Fig. 7.7 Coal

Coal is obtained through mining or in open pits. Coal is primarily used as a solid fuel to produce electricity and heat through combustion. When coal is heated in air, coal burns and produces mainly carbon-di-oxide gas. Coal is processed in industry to get some useful products such as coke, coal tar and coal gas.

Environmental effects of coal burning

1. Generation of waste products which contain mercury, uranium, thorium, arsenic and other heavy metals, which are harmful to human health and environment.
2. Sulphur particles present in the coal will cause acid rain..
3. Interference with ground water and water table levels.
4. Contamination of land and water ways.
5. Dust nuisance.
6. Release of CO_2, a green house gas, which causes climate change and global warming.
7. Coal is the largest contributor to the man-made increase of CO_2 in the air.

ACTIVITY 7.4

- Visit Neyveli lignite corporation.
- See how the coal is mined.
- Discuss with your classmates about the uses of coal.

7.5.2 Petroleum

In modern life today, we are inseparable from petrol and petroleum products.Petroleum or crude oil is a naturally occurring, toxic, flammable liquid consisting of a complex mixture of hydrocarbons and other organic compounds that are found beneath the earth's surface.

Do you know how does petroleum form?

Petroleum was formed from organisms living in the sea. After the death of those organisms, their bodies settled at the bottom of the sea and were covered with layers of sand and clay. Over millions of

years, absence of air, high temperature and high pressure transformed the dead organisms into petroleum and natural gas.

Many useful substances are obtained from petroleum and natural gas. These are used in the manufacture of detergents, fibers (polyester, nylon, acrylic etc.), polythene and other plastic substances. Hydrogen gas, obtained from natural gas, is used in the production of fertilizers (urea). Due to its great commercial importance, petroleum is also called 'Black Gold'.

Environmental effects

Oil Spills

1. Crude oil (refined fuel) spills from tanker ship and accidents have damaged natural ecosystem.
2. Oil Spills at sea are generally causing more damage than those on land. This can kill sea birds, mammals, shellfish and other organisms, because of their lateral spreading on water surface.

Tar Balls

A tar ball is a blob of oil which has been weathered after floating on the ocean. Tar balls are aquatic pollutants in most of the seas.

Fig 7.8 Petroleum Industry

Alternatives to petroleum – based vehicle fuels

1. Internal combustion engines (Biofuel or combustion hydrogen)
2. Electricity (for e.g. all electric (or) hybrid vehicles), Compressed air or fuel cells (hydrogen fuel cells).
3. Compressed natural gas used by natural gas vehicles.

7.6 GREEN CHEMISTRY

Green chemistry is the design of chemical products and processes to reduce or eliminate the use and generation of hazardous substances.

The concept of green chemistry was introduced in 1995. The Green Chemistry Institute was recently created and the Presidential Green Chemistry challenge awards were established in 1999.

MORE TO KNOW

Many countries are making commitments to lower green house gas emissions according to the Kyoto protocol.

ACTIVITY 7.5

Coal is used in thermal power stations and petroleum products like petrol and diesel are used in means of transport like motor vehicles, ships and aeroplanes. We cannot really imagine life without a number of electrical appliances and constant use of transportation. So, can you think of ways in which consumption of coal and petroleum products can be reduced?

- Greener reaction conditions for an old synthesis e.g. replacement of an organic solvent with water or the use of no solvent at all)
- A greener synthesis for an old chemical (e.g. a synthesis which uses biomass rather than petrochemical feed stock or the use of catalytic rather than stoichiometric reagents).
- The synthesis of a new compound that is less toxic but has the same desirable properties as an existing compound. (e.g. a new pesticide that is toxic only to target organisms and bio-degrades to environmentally benign substances)

Green chemistry / technology has been developed in almost all branches of chemistry including organic, bio-chemistry, inorganic, polymer, toxicology, environmental, physical, industrial etc.

The Principles of Green Chemistry

- It is better to prevent waste generation than to treat or clean up waste after it is generated.
- Wherever practicable, synthetic methodologies should be designed to use and generate substances that posses little or no toxicity to human health and the environment.
- Chemical products should be designed to preserve efficacy of function while reducing toxicity.

Fig. 7.9 Green chemistry

List of some of the products produced by the process of green chemistry

- Lead free solders and other product alternatives to lead additives in paints and the development of cleaner batteries.
- **Bio-plastics:** Plastics made from plants including corn, potatoes or other agricultural products.
- Flame resistant materials.
- Halogen free flame retardants.

e.g. silicon based materials can be used.

Future products

- A raw material feedstock should be renewable rather than depleting whenever technically and economically practical.
- Catalytic reagents are superior to stoichiometric reagents.
- Green Chemistry is applicable to all aspects of the product life cycle as well. Finally, the definition of green chemistry includes 'The term "hazardous". It is important to note that green chemistry is a way of dealing with risk reduction and pollution prevention.

PVC and Lead

New lead free solders with lower heat requirements are being developed.

Beware of Green washing

Green chemistry is not a panacea. We must be vigilant in making sure that what is called "Green Chemistry really pushes towards a more sustainable world and not simply green washing".

CHAPTER 7

7.7. SCIENCE TODAY – TOWARDS A GLOBAL VILLAGE

Global village

Global village is the term used to mean that world had shrunk into a village by means of different media types, most especially the world wide web, making It is easy to pass across messages (like news) thereby making the world become a single village where people can easily contact each other quicker.

What is global village?

A term that compares the world to a small village, where fast and modern communication allows news to reach quickly. The use of electronics for faster communication is a global village concept.

What is the global electronic village?

Global electronic village (GEV) is a term used to refer to a village without borders; it refers to connecting people around the world technologically through Information Communication Technologies (ICTS).

Fig. 7.10 Global village

Global Village (GV) is located at a distance of 12 kms from Bangalore on the Bangalore - Mysore Expressway and easily accessible by road. Spread over 110 acres of greenery, the project will house a cluster of technology companies in a campus type setting. The Buildings nestle among the lush green of manicured lawns, coconut palms and an eclectic mix of old trees in a serene and dust free environment. The Technology Campus has been conceptualized and designed by a team of reputed Indian and international architects and landscape designers.Ample residential facilities are in close proximity to the campus. The estimated driving time to GV from the heart of Bangalore city is approximately 20 minutes.

Kshema Technologies have the distinction of being the first of GTV's companies to move into the campus with an 80,000 sq ft facility to house 600 employees.

The term global village was coined by Marshall McLuhan. He emphasized that "this forces us to become more involved with one another from countries around the world and be more aware of our global responsibilities". Similarly, web-connected computers enable people to link their web sites together. This new reality has implications for forming new sociological structures within the context of culture.

EVALUATION

PART A

Multiple choice questions

1. Which of the following groups contain only bio degradable items?

   (Grass, flowers and leather ; Grass, wood and plastic ; Fruit peels, cake and plastic ; Cake, wood and grass)

2. Which of the following constitute a food chain?

   (Grass, wheat and mango ; Grass, goat and human ; Goat, cow and elephant ; Grass, fish and goat)

3. Which of the following are environmental friendly practices?

   (carrying cloth bags to carry the purchase items during shopping, switching off light and fans when not in use, use the public transport, all the above)

4. what is called as 'black gold'?

   (hydrocarbons, coal, petroleum, ether)

5. odd one out.

   (Plants, grasshopper, frog, tiger, snake)

6. Example for product of green chemistry is

   (plastic, paper, bio plastics, halogen flame retardants)

7. _____ green house gas which causes climate change and global warming.

   (hydrogen, oxygen, nitrogen, carbondioxide)

8. The _____ forms decomposer in the pond ecosystem (plants, bacteria, frog, phytoplanktons)

9. ________ chemical is used in seeding clouds (potassium iodide, calcium carbonate, sulphurdioxide, ammonium phosphate)

10. Example for fossil fuel is (copper, iron, magnesium, coal)

PART B

11. Study the food chain below, correct it and convert into a pyramid of energy.

    Mulberry -> Sparrow -> Caterpillar -> Kite

12. Study the illustration and answer the question.

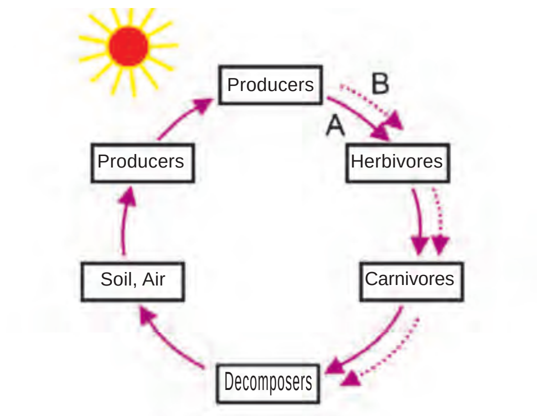
    a. which line (A or B) represent the flow of energy? Why do you say so?

    b. Give an example of a decomposer.

13. Study the food chain.

    Paddy -> Mouse -> Snake -> Kite

    If the producer has a STORED UP ENERGY OF 500 k CAL. How much of it goes to the organism at the third trophic level get from it?



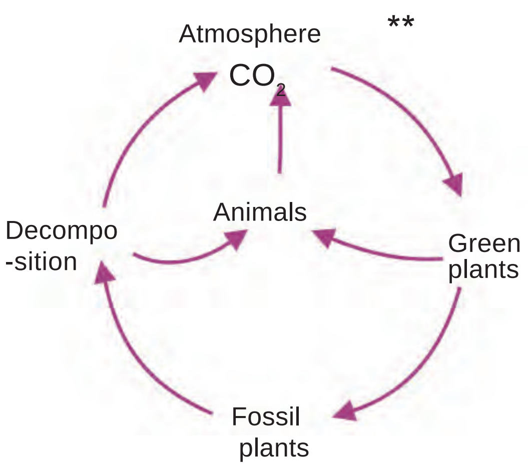
14.
   a. Name the processes noted as no. 1 and 3
   b. Define the process 1
   c. Name any one fossil fuel. (**)

PART C

15. a) Classify the following substances – wood, paper, plastic and grasses.

    b) Give detailed account on your classification.

16. In your area there is scarcity of water due to this the people are affected.



So what are the measures to be taken by you to meet out the scarcity of water.

17. Smoke, smoke everywhere smoke. Do you agree this situation is good for health. List out the harmful effects of coal burning.

Sholas and grasslands of western ghats are the sources of all our South Indian rivers. All the hillocks in the upper mountains have this unique ecosystem, which we cannot create.

FURTHER REFERENCE

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2. New development in green chemistry **V.K. Atlerwalia, M. Kidwai**

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8. Waste water management

Human beings have been abusing the water-bodies around the world by disposing into them all kinds of wastes. We tend to believe that water can wash away everything not taking cognizance of the fact that the water bodies are our life line as well as that of all other living organisms.

Can you list out the things we tend to try and wash away through our rivers and drains?

Due to such activities of human being, the ponds, lakes, streams, rivers, estuaries and oceans are becoming polluted in several parts of the world. So we should manage the waste water in order to prevent the water pollution and its effects on our life.

8.1. JOURNEY OF WATER

Water, a precious physical substance, is essential to all living organisms. All biological functions and cell metabolism require water. Because of this feature, without water, life cannot be expected on the earth.

Water cycle

Large quantity of water is present to an area of about 1400 million km^3 in the entire globe. This water evaporates from moist surfaces, falls as rain or snow, passes through lake, rivers, entered into the ground water table and to the ocean, also fixed in glaciers and deposited over mountains. Plants absorb water from the soil, utilized for its metabolic activities and release it into the atmosphere mainly through transpiration and all living organisms utilize water.

Sources of water

Water is widely distributed in nature and occurs in number of forms viz., solid, liquid and vapour. Rainfall brings the available primary source of water over the earth surface. Ocean water is the largest among all the water resources. A little quantity of water i.e., 2.4 percent, water is fresh and most of this water is in glaciers or in ground water. Geologic layers containing water is known as aquifers of underground water. On some areas of the earth's

crust, fresh water flows freely which is called as an artesian well or spring. Rivers carry huge volume of water for discharge into the lakes and ponds. Wetlands, swamps and marshes play a vital role in this journey of water.

8.2. SEWAGE

Sewage is formed from residential, institutional, commercial and industrial establishments and includes household waste liquid from toilets, baths, showers, kitchens, sinks and so forth that is disposed of via sewers.

8.3. TREATMENT

Sewage can be treated close to where it is created (in septic tanks, biofilters or aerobic treatment systems), or collected and transported via a network of pipes and pump stations to a municipal treatment plant (see sewage and pipes and infrastructure). Sewage collection and treatment is typically subject to local, state and central regulations and standards. Industrial sources of waste water often require specialized treatment process.

Conventional sewage treatment may involve three stages called primary, secondary and tertiary treatment.

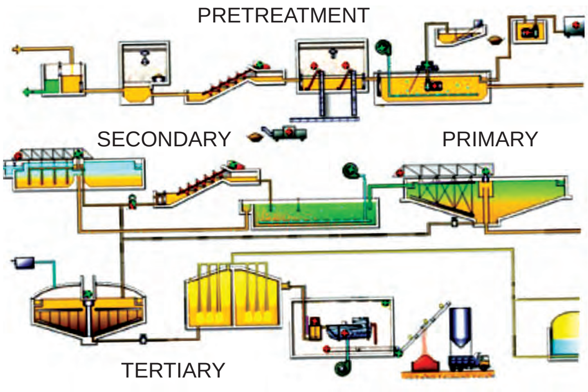


Fig. 8.1 Sewage water treatment

Primary treatment

Primary treatment consists of temporarily holding the sewage in a quiescent basin where heavy solids can settle to the bottom while oil, grease and lighter solids float over the surface. The settled and floating materials are removed and remaining liquid may be discharged or subjected to secondary treatment.

Secondary treatment

Secondary treatment is used to remove dissolved and suspended biological matter. Secondary treatment is typically performed by indigenous, water – borne micro organisms in a managed habitat. Secondary treatment may require a separation process to remove the micro organisms from the treated water prior to discharge or tertiary treatment.

Tertiary treatment

Tertiary treatment is defined as either chemical or treatment of filteration done after primary and secondary treatment. Treated water is sometimes disinfected chemically or physically (for example by lagoons and micro filtration.). Before discharging into a stream, river, bay, lagoon or wetland, or it can be used for the irrigation of a golf course, green way or park. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes.

Bioremediation in sewage treatment

Bioremediation can be defined as any process that is done by the use of microorganisms, fungi or their enzymes to treat the contaminants. Nitrosomonas europaea can be used

ACTIVITY 8.1

- Find out how the sewage in your locality is treated. Are there mechanisms to ensure that local water bodies are not polluted by untreated sewage.
- Find out how the local industries in your locality treat their wastes. Are there mechanisms in place to ensure that the soil and water are not polluted by the waste?

to treat sewage, freshwater, walls of buildings and on the surface of monuments especially in polluted areas where there is high levels of nitrogen compounds.

8.4. DOMESTIC PRACTICES:

Sewage is created by residential house hold waste liquid from toilets, bathroom, showers, kitchens, and so forth then is dispersed of via sewers.

The seperation of draining of household waste into grey water and black water is becoming more common in the developed world, with grey water being permited to be used for watering plants or recyling for flushing toilets.

Waste water

Waste water is often reffered to as grey water. Any water that has been used in the home, with the exception of water in the toilet can be reffered to as waste water.

This water could be reused for a multitude of purposes, including,

1. watering yard and gardens,
2. Filtering septic systems,
3. Irrigating fields,

Benefits of house hold waste water recycling systems,

1. Less fresh water usage,
2. Reduce strain in septic tanks,
3. Recharge ground water,
4. Encourage plant growth.

8.5. SANITATION AND DISEASES :

Water supply, sanitation and health are closely interrelated. Poor hygiene, inadequate quantities and quality of drinking water and lack of sanitation facilities cause millions of the world's poorest people to die from preventable diseases each year. Water contaminated by human, chemical or industrial wastes can cause a variety of communicable diseases through ingestion or physical contact.

Water-borne diseases

Water -borne diseases are caused by the ingestion of water communicated by human or animal faeces or urine containing pathogenic bacteria or viruses; include cholera, typhoid, amoebic and bacillary dysentery and other diarrhoeal diseases.

Water-washed diseases are caused by poor personal hygiene and skin or eye

ACTIVITY 8.2

- Practice regularly to wash your hands thoroughly before and after using the toilets.
- Food and water containers should be cleaned and has to be closed when they are in use.
- During flood and other natural calamities, water should be used only after boiling.
- People live near hazardous industrial waste accumulating or water pollution areas should be very careful in using the ground water.

contact with contaminated water; include scabies, trachoma and flea, lice and tick-borne diseases.

Water-based diseases are caused by parasites found in intermediate organisms living in water; include dracunculiasis, schistosomiasis and other helminthes.

Water-related diseases are caused by insect vectors which breed in water; include dengue, filariasis, malaria, onchocerciasis, trypanosomiasis and yellow fever.

- Contaminated water that is consumed may result in water-borne diseases including viral hepatitis, typhoid, cholera, dysentery and other diseases that cause diarrhoea.
- Without adequate quantities of water for personal hygiene, skin and eye infections spread easily.
- Water- based diseases and water-related vector-borne diseases can result from water supply projects. They inadvertently provide habitats for mosquitoes and snails. They are intermediate hosts for parasites that cause malaria, Schistosomiasis, lymphatic filariasis and Japanese encephalitis.
- Drinking water supplies that contain high amounts of certain chemicals (like arsenic and nitrates) can cause serious diseases.
- Inadequate water, sanitation and hygiene, account for a large part of the burden of illness and death in developing countries.
- Lack of clean water and sanitation is the second most important risk factor in terms of the global burden of diseases, after malnutrition.
- Approximately 4 billion cases of diarrhoea per year cause 1.5 million deaths, mostly among children under five.
- Intestinal worms infect about 10 percent of the population of the developing world, and can lead to malnutrition, anaemia and retarded growth.
- 300 million people suffer from malaria.

8.6. ALTERNATIVE ARRANGEMENT FOR SEWAGE DISPOSAL

Wherever crops are grown, they always need nutrients and water. Wastewater is often used in agriculture as it contains water, minerals, nutrients and its disposal is often expensive. Where effluent is used for irrigation, good quality water can be reserved exclusively for drinking water. Wastewater can also be used as a fertilizer, thus minimizing the need for chemical fertilizers. This reduces costs, energy, expenditure and industrial pollution. Waste water is also commonly used in aquaculture or fish farming.

8.7. SANITATION IN PUBLIC PLACES

Wherever population density is high such as bus station or school, especially when they are eating food from the same source, there is a greater risk of the spread of diseases such as, cholera, hepatitis A,-typhoid and other diarrhoeal diseases.

These places vary in the number of people using them, the amount of time that people spend there and the type of activity that occurs in the area, but all public places need to have adequate sanitation and hygiene facilities.

Basic rules for sanitation in public places

1. There should be sufficient toilet facilities.
2. The toilet facilities should be arranged in separate blocks for men and women.
3. The men's toilet block should have urinals and toilet compartments, the women's block have toilet compartments only.
4. There must be a hand washing basin with clean water.
5. There must be a clean and reliable water supply for hand washing, personal hygiene and flushing of the toilet facilities.

8.8. ENERGY MANAGEMENT

What is Energy Management?

"Energy management" is a term that has a number of meanings, but we are mainly concerned with the one that relates to saving energy in business, public-sector / government organizations and homes.

Energy saving measures

Energy management is the process of monitoring controlling and conserving energy in a living home or in any organization.

8.8.1. Energy Audit

An energy audit is an inspection, survey and analysis on energy flows for energy conservation in a building, process or system. It is done to reduce the amount of energy input into the system without negatively affecting the output(s).

Home energy audit

A home energy audit is a service where the energy efficiency of a house is evaluated by a person using professional

equipment (such as blower doors and infra-red cameras), with the aim to suggest the best ways to improve energy efficiency in heating and cooling the house.

An energy audit of a home may involve recording various characteristics of the building envelope including the walls, ceilings, floors, doors, windows and skylights. The goal of this exercise is to quantify the building's overall thermal performance. The audit may also assess the efficiency, physical condition at programming of mechanical systems such as the heating, ventilation, air conditioning equipment and thermostat.

A home energy audit may include a written report estimating energy use given local climate criteria, thermostat settings, roof overhang, and solar orientation. This could show energy use for a given time period, say a year, and the impact of any suggested improvements per year. The accuracy of energy estimates are greatly improved when the homeowner's billing history is available showing the quantities of electricity, natural gas, fuel oil, or other energy sources consumed over a one or two-year period.

A home energy audit is often used to identify cost effective ways to improve the comfort and efficiency of buildings. In addition, homes may qualify for energy efficiency grants from central government.

Energy audit in schools

The function of an energy audit is to expose different ways to affect energy consumption and identify numerous options for reducing energy consumption.

ACTIVITY 8.3

- Using a thermometer, observe the room temperature of your class room and the temperature under a Neem tree on an hot day.
- Burn the tungsten lamp and compressed fluorescent lamps and compare the energy consumption.

The money your school saves will be available to fund important school projects, but just as important, energy savings help the Earth by reducing resource use and environmental pollution. By improving efficiency in places like our schools, we can get the same benefits while using less energy. For example, substituting energy efficient, compact fluorescent light bulbs (CFL) for standard incandescent bulbs will save on average up to 6,000 megawatts of electricity each year.

There are many ways you can help your school save money on water usage, such as checking for leaks in the system, reducing water usage (especially hot water), and improving the efficiency of water delivery.

Another important way to save energy at your school is through recycling. This can be done all over the school. For example, you can save by recycling paper milk cartons from the lunch room or printer cartridges in the copy room. By recycling paper, milk cartons and other

materials, schools are able to reduce the amount of waste they produce. This can garner significant savings as well as benefit the environment.

8.8.2. Renewable sources

A natural resource is a renewable resource, if it is replaced by natural processes at a rate comparable or faster than its rate of consumption by humans. Solar radiation, Hydrogen, Wind and hydroelectricity are in no danger of a lack of long term availability.

Solar Energy

Solar energy is the energy derived directly from the sun. Along with nuclear energy, it is the most abundant source of energy on earth. The fastest growing type of alternative energy increasing at 50 percent a year ,is the photovoltaic cell, which converts sunlight directly into electricity. The sun yearly delivers more than 10000 times the energy that humans currently use.

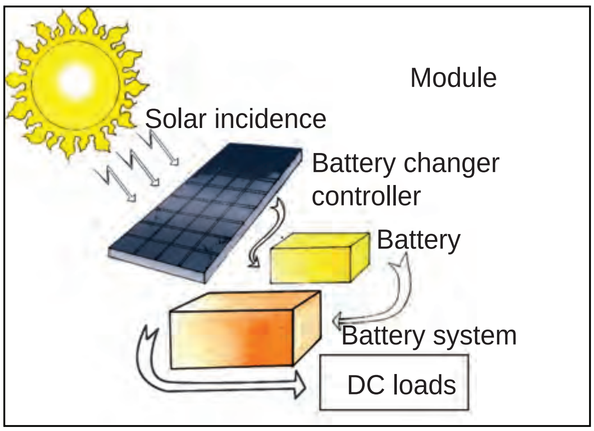


Fig. 8.2 Solar Energy

Hydrogen

The hydrogen has been found to be a good choice among all the alternative fuel options . It can be produced in virtually unlimited quantities with on hand production technologies. It has been established that hydrogen can meet all the energy needs of human society, including power generation more efficiently and more economically than petro fuels, and with total compatibility with the environment. In addition, hydrogen is non-toxic reasonably safe to handle, distribute and use as a fuel. Hydrogen has the highest mass energy content – its heat of combustion per unit weight is about 2.5 times that of hydro carbon fuel, 4.5 times that of ethanol and 6.0 times that of methanol. Its thermodynamic energy conversion efficiency of 30-35 % is greater than that of gasoline (20-25%).

ACTIVITY 8.4

- Study the structure and working of a solar cooker and / or a solar water heater, particularly with regard to how it is insulated and maximum heat absorption is ensured.
- Design and build a solar cooker or water heater using low cost material available and check what temperatures are achieved in your system.
- Discuss what would be the advantages and limitations of using solar cooker or water heater.

Wind Power

Wind power is derived from uneven heating of the Earth's surface from the sun and the warm core. Most modern wind power is generated in the form of electricity by converting the rotation of turbine blades into electrical current by means of an electrical generator. In wind mills (a much older technology) wind energy

MORE TO KNOW

Denmark is called the country of "winds". More than 25% of their electricity needs are generated through a vast network of windmills. In terms of total output, Germany is the leader, while India is ranked 5th in harnessing wind energy for the production of electricity. It is estimated that nearly 45000MW of electrical power can be generated if India's wind potential is fully exploited. The largest wind energy farm has been established near Kanyakumari in Tamilnadu and it generates 380MW of electricity.

is used to turn mechanical machinery to do physical work, like crushing grain or pumping water.

Fig. 8.3 Windmills

8.8.3. Non-renewable sources

A non-renewable resource is a natural resource which cannot be produced, grown, generated or used on a scale which can sustain its consumption rate. These resources often exist in a fixed amount, or are consumed much faster than nature can create them. Fossil fuels (such as coal, petroleum and natural gas) and nuclear power (uranium) are example.

Fossil Fuels

Fossil fuels are energy rich, combustible forms of carbon or compounds of carbon formed by the decomposition of biomass buried under the earth over million of years.

Fig. 8.4 Coal mining

Fossil Fuel – Coal

It is a black mineral of plant origin which is chemically, a complex mixture of elemental carbon, compounds of carbon containing hydrogen, oxygen, nitrogen and sulphur.

Petroleum

Petroleum is a dark, viscous, foul smelling liquid, a mixture of solid, liquid and gaseous hydro carbons with traces of salt, rock particles and water.

ACTIVITY 8.5

- Debate the following two issues in class.
- The estimated coal reserves are said to be enough to last us for another 200 years. Do you think we need to worry about coal getting depleted in this case? Why or why not?
- It is estimated that the sun will last for another 5 billion years. Do we have to worry about solar energy getting exhausted? Why or why not?
- On the basis of the debate, decide which energy sources can be considered i) exhaustible ii) inexhaustible iii) renewable iv) non-renewable. Give your reasons for each choice.

Natural Gas

The composition of natural gas is chiefly methane (> 90%) with traces of ethane and propane. It is found associated with other fossil fuels, in coal beds, as methane clathrates and it is created by methanogenic organisms in marshes, bogs, and land fills. It is an important fuel source, a major feedstock for fertilizers and a potent green house gas.

Before natural gas can be used as a fuel, it must undergo extensive processing to remove almost all materials other than methane. These by-products of that processing include ethane, propane, butane, pentane and higher molecular weight hydrocarbons, elemental sulphur, carbon-di-oxide, water vapour and sometimes helium and nitrogen.

Natural gas is often informally referred to as simply gas, especially when compared to other energy sources such as oil or coal.

USES

Power Generation: Natural Gas is a major source of electricity generation through the use of gas turbines and steam turbines. Most grid peaking power plants and some off – grid engine – generators use natural gas.

Domestic use: Natural gas is supplied to homes where it is used for such purposes as cooking in natural gas – power rangers and oven, natural gas heater clothes dryers, heating or cooling and central heating. Home or other building heating may include boilers, furnaces and water heaters.

Natural gas is a major feedstock for the production of ammonia, for use in fertilizer production.

Other: Natural gas is also used in the manufacture of fabrics, glass, steel, plastics, paint and other products. With man's ever increasing need for energy , he has been using fossil fuels indiscriminately. In the process, harmful materials contributing to air pollution are being produced.

8.8.4. Bio-fuels – Generation and use

Biofuels are a wide range of fuels which are in some way derived from biomass. The term covers solid biomass, liquid fuels and various biogases. Bio fuels are gaining increased public and scientific attention driven by factors such as oil price hikes, the need for increased energy security and concern over green house gas emissions from fossil fuels.

The various liquid bio fuels for transportation are

1. Bio alcohol
2. Green diesel
3. Bio diesel
4. Vegetable oil
5. Bio ethers
6. Bio gas

Bioalcohol (Bioethanol)

Bioethanol is an alcohol made by fermenting the sugar components of plant materials and it is made mostly from sugar and starch crops. With advanced technology being developed, cellulosic biomass, such as trees and grasses are also used as feed stocks for ethanol production. Ethanol can be used as a fuel for vehicles in its pure form. Bioethanol is widely used in the USA and Brazil.

Biodiesel: Biodiesel is made from vegetable oil and animal fats. It is used as a fuel for vehicles in its pure form.

Biogas: Biogas is produced by the process of anaerobic digestion of organic material by anaerobes. It can be produced either from bio degradable waste material or by the use of energy crops fed into anaerobic digesters to supplement gas yields. The solid by product, digestable can be used as biofuel or fertilizer.

8.8.5 ENERGY CONSERVATION & HOW WE CAN HELP

Energy conservation

Energy conservation refers to efforts made to reduce energy consumption in order to preserve resources for the future and reduce environmental pollution. It can be achieved through efficient energy use or by reduced consumption of energy services. Energy conservation may result in increase of financial capital, environmental value, national security, personal security and human comfort. Individuals and organizations that are direct consumers of energy may want to conserve energy in order to reduce energy costs and promote economic security. Industrial and commercial users may want to increase efficiency and thus maximize profit. Electrical energy conservations are the important element of energy policy.

Lighting

1. Turn off the lights when not in use.
2. De-dust lighting fixtures to maintain illumination.
3. Focus the light where you need.
4. Use fluorescent bulbs.
5. Use electronic chokes in place of conventional copper chokes.

Fans

1. Replace conventional regulators with electronic regulators for ceiling fans.
2. Install exhaust fans at a higher elevation than ceiling fans.

Electric Iron

1. Select iron boxes with automatic temperature cut off.
2. Use appropriate regulator position for ironing.

3. Do not put more water on clothes while ironing.
4. Do not iron wet clothes.

Gas Stove

1. When cooking on a gas burner, use moderate flame settings to conserve LPG.
2. Remember that a blue flame means your gas stove is operating efficiently.
3. If there is yellowish flame, this indicates that the burner needs cleaning.
4. Use pressure cooker as much as possible.
5. Use lids to cover the pans while cooking.
6. Use solar water heater – a good replacement for a electric water heater.

Electronic Devices

1. Do not switch on the power when TV and Audio systems are not in use. i.e., idle operation leads to an energy loss of 10 watts / device.
2. Battery chargers such as those for laptops, cell phones and digital cameras, draw power whenever they are plugged in and are very inefficient. Pull the plug and save.

Washing Machine

1. Always wash only with full loads.
2. Use optimal quantity of water.
3. Use timer facility to save energy.
4. Use the correct amount of detergent.
5. Use hot water only for very dirty clothes.
6. Always use cold water in the rinse cycle.

EVALUATION

PART A

1. Example for water-borne disease is

   (scabies, dracunculiasis, trachoma, typhoid)

2. The settled and floating materials are removed by this treatment method.

   (primary treatment, secondary treatment, tertiary treatment, peripheral treatment)

3. Which is a non-renewable resource?

   (coal, petroleum, natural gas, all the above)

4. ----------- is the chief component of natural gas.

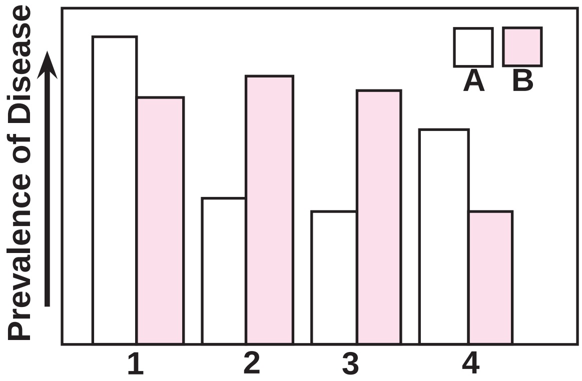
   (ethane, methane, propane, butane)

PART B

5. The bar graph indicates the presence of the infectious diseases in two cities A and B. Observe it and answer the questions given below.

   1. Dengue fever 2. Rat fever
   3. Cholera 4. Chikungunya

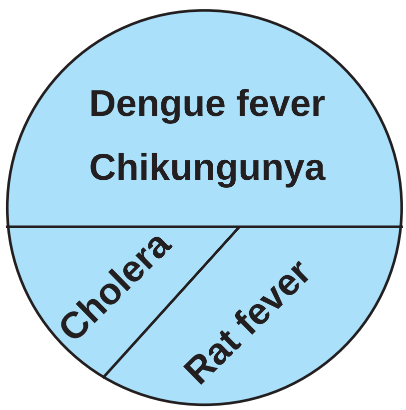
   a. What may be the reason for the disease in the city A?



b. Which city needs more careful waste disposal and cleaning?

c. How can the disease be controlled in city A?

6. The pie diagram represents a survey result of infectious diseases of a village during 2008 – 2009. Analyse it and answer the following chart



Which diseases affect the majority of the population?

a. How are these diseases transmitted?

b. Write any three measures to control the other two diseases.

7. Match the suitable renewable and non-renewable sources.

Sources	A	B	C
Renewable	Coal	Wind	Petroleum
Non-Renewable	Hydrogen	Natural gas	Solar energy

8. Odd one out

a. bio alcohol, green diesel, bio ethers, petroleum

b. cholera, typhoid, scabies, dysentry

9. A non renewable resource is a natural resource if it is replaced by natural process at a rate comparable or faster than its rate of consumption by humans. Read this statement and confirm whether it is correct or incorrect. If it is incorrect give correct statement.

10. Pick out the suitable appliances to conserve the electric energy.

Florescent bulbs, copper choke, solar water heater, electric water heater, tungsten bulbs, electronic choke.

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Website: 2. Sewage, en.wikipedia-org/wiki/sewage -treatment.

Chapter 9

SOLUTIONS

9. Solutions

Result of health drink

Health drink

Anu has got back home from playfield after winning a match. She is received by her mother cheerfully with a glass of health drink.

Anu: Mother! What is this?

Mother: This is your health drink – a solution of fruit juice and sugar for your revitalisation.

Solutions are of great importance in **everyday** life. The process of food assimilation by man is in the form of solution. Blood and lymph are in the form of solution to decide the physiological activity of human beings.

A solution is a homogeneous mixture of two (or) more substances.

All solutions exist in homogeneous form. **Homogeneous** refers to the state in which two (or) more substances, that are uniformly present in a given mixture. If a solution contains two components, then it is called as a **Binary Solution**.

Salt solution containing common salt in water is a suitable example for binary solution.

Fig. 9.1 A solution is a homogenous mixture of solute and solvent

9.1. SOLUTE AND SOLVENT

In a solution, the component present in lesser amount by weight is called **solute** and the component present in a larger amount by weight is called **solvent.** Generally a solvent is a dissolving medium. It surrounds the particles of solute to form solution.

In short, a solution can be represented, as follows

(Solute + Solvent → Solution)

9.2. TYPES OF SOLUTIONS

9.2.1. Based on the particle size

Based on the particle size of the solute, the solutions are divided into three types.

1. **True solutions:** It is a homogeneous mixture that contains small solute particles that are dissolved throughout the solvent eg. Sugar in water.

2. **Colloidal solutions:** It is a heterogeneous mixture made up of two phases namely, dispersed phase and dispersion medium. The substance distributed as particles is called **dispersed phase.** The continuous phase in which the colloidal particles are dispersed is called **dispersion medium.**

(Dispersed phase + Dispersion medium → Colloidal solution)

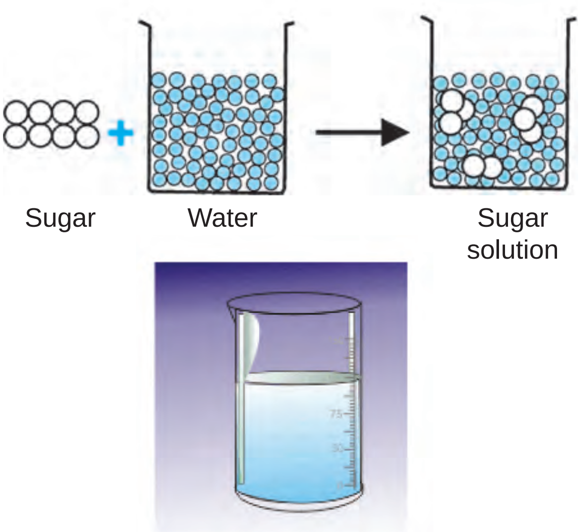


Fig. 9.2 Mixture of sugar and water forming true solution

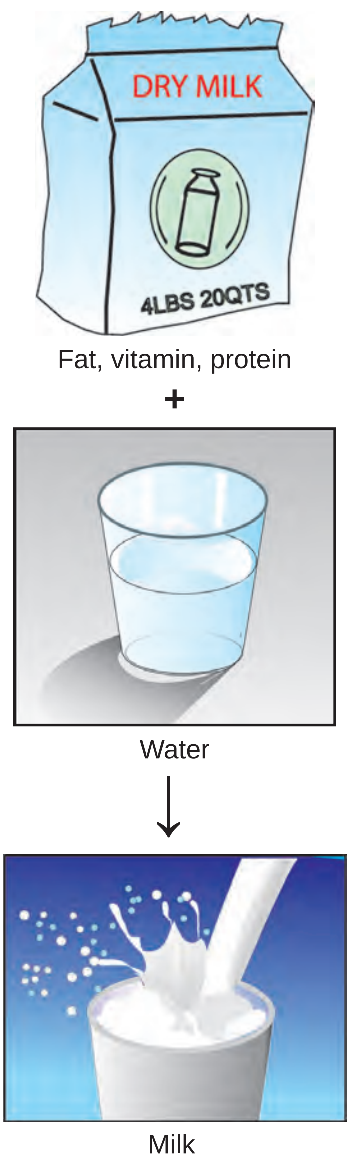
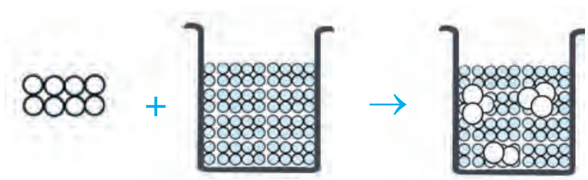


Fig. 9.3 A mixture of milk powder and water forming colloid

3. Suspensions: It is a heterogeneous mixture of small insoluble particles in a solvent. In a suspension, the particles of solid stay in clusters that are large enough to be seen (e.g. Chalk powder in water).



Chalk + Water → Suspension

Fig. 9.4 A mixture of chalk and water forming suspension

MORE TO KNOW

Tyndall effect, The phenomenon by which colloidal particles scatter light is called **Tyndall effect**. If a beam of light is allowed to pass through a true solution, some of the light will be absorbed and some will be transmitted. The particles in true solution are not large enough to scatter the light. However if light is passed through a colloidal solution, the light is scattered by the larger colloidal particles and the beam becomes visible. This effect is called TYNDALL EFFECT

ACTIVITY 9.1

Students may be asked to observe the scattering of light (Tyndall effect) when sunlight passes through the window of the class rooms. The dust particles scatter the light making the path of the light visible.

Fig. 9.5 Tyndall effect in nature

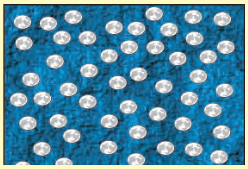
MORE TO KNOW

Brownian motion: The phenomenon by which the colloidal particles are in continuous random motion is called **Brownian motion.**

Brownian motion is named in honour of ROBERT BROWN a biologist.He observed the motion of the particles in suspension of pollen grains in water.

Fig. 9.6 Brownian motion

Comparing the properties of true solution,colloidal solution and suspension

Property	True Solution	Colloidal Solution	Suspension
Particle size in Å (1Å = 10^{-10}m)	 1Å to 10 Å	 10Å to 1000 Å	 More than 1000 Å
Appearance	Transparent	Translucent	Opaque
Visibility of particles	Not visible even under ultra microscope	Visible under ultra microscope	Visible to the naked eye
Nature	Homogeneous	Heterogeneous	Heterogeneous
Diffusion of particles	diffuses rapidly	diffuses slowly	diffusion does not occur
Scattering effect	Does not scatter light	It scatters light	It does not scatter light

9.2.2. Based on the type of solvent.

Based on the type of solvent solutions are classified into two types

1. **Aqueous solution:** The solution in which water acts as a solvent, is called **aqueous solution**. For e.g., sugar solution.
2. **Non-aqueous solution:** The solution in which any liquid other than water acts as a solvent is called **non-aqueous solution**. Solution of sulphur in carbon disulphide is a suitable example for non-aqueous solution. (Benzene, ether, CS_2, are some of the examples for non aqueous solvents.)

9.2.3. Based on the amount of solute in the given solution

Based on the amount of solute in the given amount of solvent, solutions are classified into the following types.

1. Unsaturated solution
2. Saturated solution
3. Super saturated solution

1. **Unsaturated solution:** A solution in which the solute is in lesser amount in comparison with the solvent is called unsaturated solution. In this, addition of solute is possible till the solution reaches the point of saturation.

   e.g., 5g or 10g or 20g of NaCl in 100g water

2. **Saturated solution:** A solution in which no more solute can be dissolved in a definite amount of solvent at a given temperature is called a saturated solution e.g.,

i) A saturated solution of CO_2 in H_2O

ii) 36g of NaCl in 100g of water at room temperature forms saturated solution

3. Super saturated solution: A solution which has more of solute at a given temperature than that of saturated solution is called **super saturated solution**.

MORE TO KNOW

Nitrogen in earth soil is an example for saturated solution in nature. (Earth soil cannot store more N_2 than it can hold)

ACTIVITY 9.2

Test whether a solution is saturated, unsaturated or super-saturated with respect to the addition of salt at a particular temperature to the solution.

Take a beaker containing 100ml of water, three packets of common salts each weighing 20g, 16g, and 1g and a glass stirrer (see fig 9.7).

Record your observations after the addition of each packet in the given order followed by stirring at each stage.

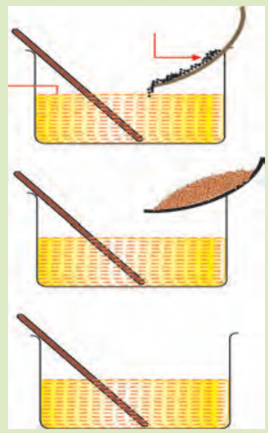


Fig. 9.7 To test Saturation, Unsaturation and Super Saturation in a given solution

9.2.4 Based on the physical state of the solute and the solvent the solutions are of 9 types.

Solute	Solvent	Examples
Solid	Solid	Alloys
Solid	Liquid	Sugar solution
Solid	Gas	Smoke
Liquid	Solid	Cheese
Liquid	Liquid	Milk
Liquid	Gas	Cloud
Gas	Solid	Cork
Gas	Liquid	Soda water
Gas	Gas	Helium-oxygen mixture (for deep sea diving)

9.3. SOLUBILITY

Solubility of a solute in a given solvent at a particular temperature is defined as the number of grams of solute necessary to saturate 100g of the solvent at that temperature. For example

Solubility of $CuSO_4$ in H_2O is 20.7g at 20°C

MORE TO KNOW

Dilute and concentrated solutions: Concentration of a solution is the amount of solute dissolved in a given amount of solvent. A solution containing less amount of solute is known as dilute solution whereas a solution containing large amount of solute is known as concentrated solution. It may be noted that dilute and concentrated are the relative terms and they have only quantitative meaning.

ACTIVITY 9.3

Determine the solubility of a solid (say KCl) in water at room temperature.

- Prepare saturated solution of KCl in about 30 ml of water at room temperature. Add more of KCl ensuring that solution is saturated and some KCl is left undissolved.
- Filter the solution to remove solid KCl.
- Find temperature of the solution by dipping a thermometer in it.
- Evaporate the solution to dryness by using a low flame to avoid bumping.
- Allow the dish and solid to cool to room temperature. Place the dish and solid in a dessicator containing anhydrous calcium chloride (calcium chloride is dehydrating agent, it absorbs moisture).

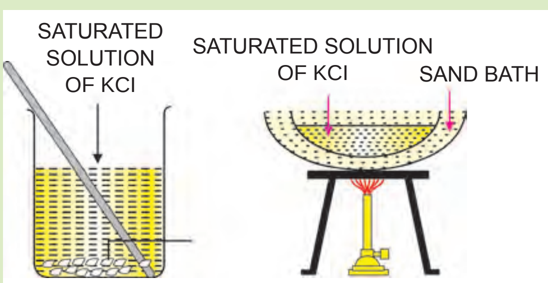


Fig. 9.8 Determination of solubility

- Take out the evaporating dish and again weigh it.
- The observation and calculation are given as follows.

Observation

Weight of the dish = Wg

Weight of dish + saturated solution of KCl = W_1g

Weight of dish + dry KCl = W_2g

Calculation

Weight of saturated solution = $(W_1 - W)$g

Weight of KCl = $(W_2 - W)$g

Weight of water present in saturated solution

$$= [(W_1 - W) - (W_2 - W)]\text{g}$$

$$= [(W_1 - W_2)]\text{g}$$

$$\textbf{Solubility of KCl} = \frac{\textbf{Weight of KCl}}{\textbf{Weight of solvent}} \times \mathbf{100}$$

$$= \frac{(W_2 - W)}{(W_1 - W_2)} \times 100$$

Tit Bit

100 ml of water can dissolve 36g of NaCl at 25° C to attain saturation.

Solubility of some ionic compounds at 25°c

Substance	Solubility (g per 100g water)
NaCl	36g
NaBr	95g
NaI	184g
$NaNO_3$	92g

9.4. FACTORS AFFECTING SOLUBILITY

1. Temperature
2. Nature of solute (or) solvent
3. Pressure

1. Effect of temperature

In endothermic process, solubility increases with increase in temperature.

E.g., Solubility of KNO_3 increases with the increase in temperature.

In exothermic process, solubility decreases with increase in temperature.

E.g., Solubility of CaO decreases with increase in temperature.

2. Nature of solute and solvent

Solubility of a solute in a solvent depends on the nature of both solute and solvent. A polar compound dissolves in a polar solvent.

E.g., Common salt dissolves in water. A polar compound is less soluble (or) insoluble in a non polar solvent.

3. Effect of pressure

Effect of pressure is observed only in the case of gases. An increase in pressure increases the solubility of a gas in a liquid. For eg. CO_2 gas is filled in soft drinks using the effect of pressure.

Fig. 9.9 CO_2 filled in soft drinks

MORE TO KNOW

Increase in pressure increases the solubility of gases. At a given temperature, the mass of gas dissolved in a fixed volume of liquid is directly proportional to the pressure of the gas on the surface of the liquid. This is called **Henry's Law.**

CHEMISTRY

PROBLEM 1

Take 10g of common salt and dissolve it in 40g of water. Find the concentration of solution in terms of weight percent.

Weight percent

$$= \frac{\text{Weight of the solute}}{\text{Weight of solute + Weight of solvent}} \times 100$$

$$= \frac{10}{10 + 40} \times 100 = 20\%$$

PROBLEM 2

2g of potassium sulphate was dissolved in 12.5 ml of water. On cooling, the first crystals appeared at 60°C. What is the solubility of potassium sulphate in water at 60°C?

SOLUTION

12.5 ml of water weighs 12.5g.

In 12.5g of water, amount of potassium sulphate dissolved, is 2g

In 1g of water, amount of potassium sulphate dissolved, is 2/12.5 g

Hence in 100g of water, amount of potassium sulphate dissolved, is (2 x 100)/12.5=16g.

The solubility of potassium sulphate in water at 60ºC is 16g.

PROBLEM 3

50g of saturated solution of NaCl at 30ºC is evaporated to dryness when 13.2g of dry NaCl was obtained. Find the solubility of NaCl at 30ºC in water.

Mass of water in solution = 50-13.2 = 36.8g

Solubility of NaCl =

$$\frac{\text{Mass of NaCl}}{\text{Mass of water}} \times 100 = \frac{13.2}{36.8} \times 100 = 36g$$

Solubility of NaCl = 36g (appx.)

PROBLEM 4

An empty evaporating dish weighs 20.0g On the addition of saturated solution of $NaNO_3$, the dish weighs 66.0g. When evaporated to dryness, the dish with crystals weighs 41.5g. Find the solubility of $NaNO_3$ at 20ºC.

SOLUTION

Weight of saturated solution of $NaNO_3$ = (66.0 – 20.0) g = 46.0g

Weight of crystals of $NaNO_3$ = (41.5-20.0) g = 21.5g

Weight of water in saturated solution = (46.0-21.5) g = 24.5g

Solubility of $NaNO_3$ =

$$\frac{\text{Weight of } NaNO_3 \text{ Crystals}}{\text{Weight of water}} \times 100$$

$$= \frac{21.5}{24.5} \times 100 = 87.7g$$

Solubility of $NaNO_3$ at 20ºC is = 87.7g in 100g H_2O

CHAPTER 9

EVALUATION

PART - A

1. A true solution is a homogenous mixture of solute and solvent. Chalk powder in water is a heterogenous mixture. Is it a true solution?

2. Solution that contains water as the solvent is called aqueous solution. If carbon disulphide is a solvent in a given solution, then the solution is called _______.

3. Solubility of common salt in 100g water is 36g. If 20g of salt is dissolved in it how much more is required to attain saturation.

4. If two liquids are mutually soluble, they are called ________ liquids. (miscible, immiscible)

5. When sunlight passes through window of the classrooms its path is visible. This is due to ________of light. (reflection, scattering)

6. The particles in various forms are visible only under ultramicroscope. A solution containing such particles is called ___________. (True solution/ colloidal solution)

7. The mixture of gases used by deep sea divers is ________(Helium-oxygen, oxygen-nitrogen)

8. Earth soil cannot store more nitrogen than it can hold. Hence earth soil is referred to be in a state of __________. (saturation, unsaturation)

9. In an endothermic process, solubility increases with __________ in temperature. (increase, decrease)

PART - B

10. From the table given below , furnish your points of inferences.

Substance	Solubility at 25°C
NaCl	36g
NaBr	95g
NaI	184g

11. Distinguish between the saturated and unsaturated solution using the data given below at a temperature of 25°C

    A. 16g NaCl in 100g water
    B. 36g NaCl in 100g water

12. You have prepared a saturated solution of sugar. Is it possible to dissolve some more grams of sugar to this solution? Justify your stand.

13. Find the concentration of solution in terms of weight percent if 20 gram of common salt is dissolved in 50 gram of water.

FURTHER REFERENCE :

BOOKS: 1. Physical Chemistry: **Puri & Sharma** - Vishal Publication
2. Advanced Chemistry: **Bahl & Arun Bahl** - S.Chand publishers

WEBSITE: www.chemistry explained.com www.sparknotes.com

10. Atoms & molecules

ATOMS AND MOLECULES

Rani shows a piece of chalk to Vani & asks her to break it into minute particles. The breaking spree, goes on and on endlessly and finally they come to conclude that the minute particle is a group of invisible atoms. They get set to probe further.

EXPLORING THE ATOM

The word atom is derived from the Greek word **"Atomos"** which means indivisible. John Dalton modeled atoms as hard indivisible spheres.

His theory remained undisputed for about a century without any changes. However towards the end of 19th and in the beginning of 20th centuries, the introduction of matter wave concept by de Broglie, the principle of uncertainty by Heisenberg etc., paved the way for **modern atomic theory or modified atomic theory.**

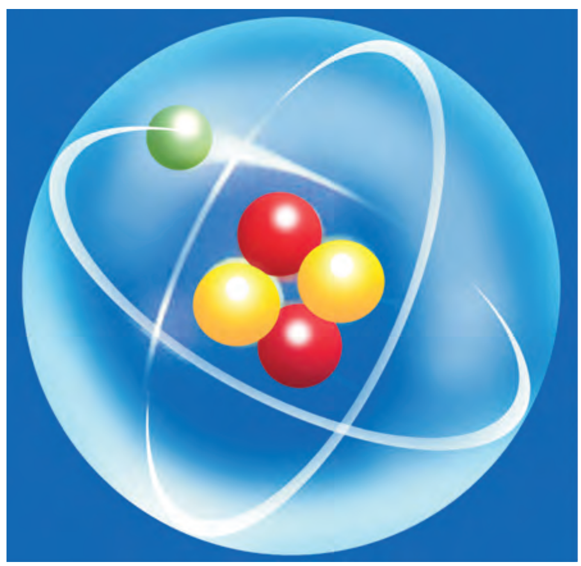


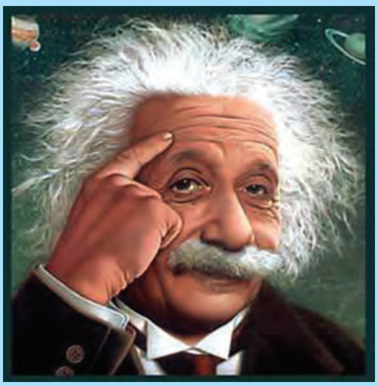
Fig. 10.1 Inner View of an atom

10.1. MODERN ATOMIC THEORY

The findings of **modern atomic theory** are given as follows.

- Atom is considered to be a divisible particle.
- Atoms of the same element may not be similar in all respects.
  eg: Isotopes (Cl^{35}_{17} , Cl^{37}_{17})
- Atoms of different elements may be similar in some respects
  eg. Isobars (Ar^{40}_{18}, Ca^{40}_{20})
- Atom is the smallest particle which takes part in chemical reactions.
- The ratio of atoms in a molecule may be fixed and integral but may not be simple
  e.g., $C_{12}H_{22}O_{11}$ is not a simple ratio (Sucrose)

ALBERT EINSTEIN



When a nuclear reaction occurs the mass of the product is found to be less than the starting mass. The difference in mass is converted into energy in accordance with the equation $E = mc^2$, where E = energy liberated, m = disappeared mass and c = speed of light. This famous equation of Einstein, made revolution in nuclear science.

- Atoms of one element can be changed into atoms of other element by transmutation.
- The mass of an atom can be converted into energy. This is in accordance with Einstein's equation $E = mc^2$

10.2. AVOGADRO'S HYPOTHESIS

Amedeo Avogadro put forward hypothesis and is based on the relation between number of molecules and volume of gases.

Avogadro's Law: Equal volumes of all gases under the same conditions of temperature and pressure contain the equal number of molecules.

Importance of Avogadro's law: This law plays an important role in

(a) deducing atomicity of gases and

(b) establishing the relation between vapour density and molecular mass.

10.2.1. Atomicity

The number of atoms present in one molecule of an element is called the atomicity of an element.

Depending upon the number of atoms in one molecule of an element, molecules are classified into monoatomic, diatomic, triatomic, and poly atomic molecules.

For any homo atomic molecule atomicity can be deduced using the formula

$$\text{Atomicity} = \frac{\text{Molecular Mass}}{\text{Atomic mass}}$$

Avogadro's law enables us to change over directly from a statement about volume of gases to a statement about molecules of gases and vice-versa.

MORE TO KNOW

Isotopes ⇒ These are the atoms of same element with same atomic number (Z) but different mass number (A). example *(Cl^{35}_{17}, Cl^{37}_{17})*

Isobars ⇒ These are the atoms of the different element with same mass number but different atomic number. example *(Ar^{40}_{18}, Ca^{40}_{20})*

Isotones ⇒ These are the atoms of different elements with same number of neutrons example : *(C^{13}_{6}, N^{14}_{7})*

Atomicity	No. of atoms per molecule	Eg
Monoatomic	1	Helium (He) Neon (Ne) Metals
Diatomic	2	Hydrogen H_2 Chlorine Cl_2
Triatomic	3	Ozone (O_3)
Polyatomic	>3	phosphorous P_4 Sulphur S_8

e.g.,

N_2 + O_2 → 2 NO

Nitrogen Oxygen Nitric oxide

(1 Vol) (1 Vol) (2 Vols)

After applying Avogadro's law, the equation becomes

N_2 + O_2 → 2 NO

1 Molecule 1 Molecule 2 Molecules

MORE TO KNOW

Avogadro an Italian Scientist (1766 – 1856) He was the one to propose that volume of a gas at a given temperature and pressure is proportional to the number of particles.

TEST YOUR UNDERSTANDING SKILL

1. Find the atomicity of chlorine if its atomic mass is 35.5 and its molecular mass is 71
2. Find the atomicity of ozone if its atomic mass is 16 and its molecular mass is 48

It is found that two molecules of nitric oxide contains 2 atoms of nitrogen and 2 atoms of oxygen.

These two atoms of nitrogen and the two atoms of oxygen should have come from 1 molecule of nitrogen and 1 molecule of oxygen, respectively.

Hence, nitrogen and oxygen are called **diatomic molecules** and are written as N_2 and O_2.

This proves that, atomicity of nitrogen is 2 and the atomicity of oxygen is 2

Thus Avogadro's hypothesis is used in the deduction of atomicity of elementary gases.

10.2.2. To establish the relationship between vapour density and relative molecular mass of a gas

i. **Relative Molecular Mass:** It is defined as the ratio of the mass of 1 molecule of the gas or vapour to the mass of 1 atom of hydrogen.

$$\text{Relative molecular mass of a gas} = \frac{\text{Mass of 1molecule of the gas or vapour}}{\text{Mass of 1 atom of hydrogen}}$$

ii. **Vapour Density (V.D):** It is defined as the ratio of the mass of a certain volume of the gas or vapour to the mass of the same volume of hydrogen at the same temperature and pressure.

$$V.D = \frac{\text{Mass of 1 volume of gas or vapour}}{\text{Mass of 1 volume of hydrogen}}$$

Applying Avogadro's Law,

$$V.D = \frac{\text{Mass of 1 molecule of gas or vapour}}{\text{Mass of 1 molecule of hydrogen}}$$

Since hydrogen is diatomic,

$$V.D = \frac{\text{Mass of 1 molecule of gas or vapour}}{2 \times \text{Mass of 1 atom of hydrogen}}$$

Multiplying both sides by 2, we get

$$2 \times V.D = \frac{\text{Mass of 1 molecule of gas or vapour}}{\text{Mass of 1 atom of hydrogen}}$$

2 x V.D = relative molecular mass of a gas or vapour

2 x Vapour density = Relative molecular mass

How to arrive at the value of *GRAM MOLAR VOLUME (GMV)*

$$GMV = \frac{\textit{GRAM MOLAR MASS}}{\textit{DENSITY OF GAS AT STP}}$$

To find the value of

$$\text{GMV OF OXYGEN} = \frac{\text{GMM of } O_2}{\text{DENSITY OF } O_2}$$

$$= 32/1.429$$

$$= 22.4 \text{ lit}$$

Therefore GMV = 22.4 litre at STP

MORE TO KNOW

Gay-Lussac's law of combining volumes of gases

Whenever gases react, they do so in volumes which bear a simple ratio to one another, and to the volumes of the gaseous products, provided, all the volumes are measured under the same conditions of temperature and pressure.

10.2.3. Applications of Avogadro's law

1. It is used to determine the atomicity of gases.

2. It is helpful in determining the molecular formula of gaseous compound.
3. It establishes the relationship between the vapour density and molecular mass of a gas.
4. It gives the value of molar volume of gases at STP. Molar Volume of a gas at STP=22.4 lit (or) 22400 cm^3.
5. It explains Gay Lussac's law effectively.

10.3. ATOMS AND MOLECULES

Atoms and molecules are the building blocks of matter.

10.3.1. Atom: It is the ultimate particle of an element which may or may not have independent existence. The atoms of certain elements such as hydrogen, oxygen, nitrogen, etc. do not have independent existence whereas atoms of helium,neon,argon,etc. do have independent existence. All elements are composed of atoms.

10.3.2. Molecule: A molecule is the simplest structural unit of an element (or) a compound which contains one (or) more atoms. It retains the characteristics of an element.

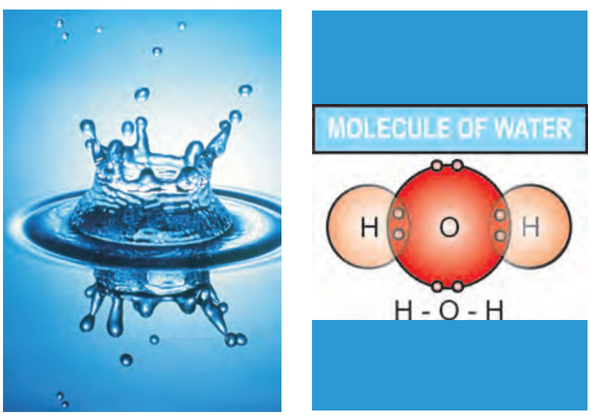


Fig 10.2 Molecule of water

POINT TO EXPLORE

Name the elements and find their number in one molecule of a) Nitrogen b) Water c) Ammonia d) Sulphuric acid.

A molecule can exist freely and it is a combined form of bonded units whereas an atom is a singular smallest form of non bonded unit.

10.3.3. Differences between atom and molecule:

Atom	Molecule
An atom is the smallest particle of an element.	A molecule is the smallest particle of an element or a compound.
An atom is a non bonded entity	A molecule is a bonded entity
An atom may or may not exist freely	A molecule can exist freely

Molecules are of two types, namely homo atomic molecules and hetero atomic molecules.

1. Homo atomic molecules

These are the molecules which are made up of atoms of the same element.

Most of the elementary gases consist of homo atomic molecules. For example hydrogen gas consists of two atoms of hydrogen (H_2).Similarly oxygen gas consists of two atoms of oxygen (O_2). In accordance with the number of atoms present in these molecules they are classified as monoatomic, diatomic, triatomic or poly atomic molecules showing that they contain one, two, three, or more than three atoms respectively.

The molecules are made up of atoms of different elements. They are also classified as diatomic, triatomic, or polyatomic molecules depending upon the number of atoms present. H_2O, NH_3, CH_4, etc., are the examples for **hetero atomic molecules**.

10.4. RELATIVE ATOMIC MASS (RAM)

10.4.1. Definition (based on hydrogen scale)

The relative atomic mass of an element

$$RAM = \frac{\text{Mass of 1 atom of an element}}{\text{Mass of 1 atom of hydrogen}}$$

is the ratio of mass of one atom of the element to the mass of one atom of hydrogen taken as one unit.

10.4.2. Definition (based on carbon scale)

$$RAM = \frac{\text{Mass of 1 atom of an element}}{\frac{1}{12}\text{ th part of the mass of one atom of carbon}}$$

Relative atomic mass of an element is the ratio of mass of one atom of element to the **1/12**th part of mass of one atom of carbon.

Relative atomic mass is a pure ratio and has no unit. If the atomic mass of an element is expressed in grams, it is known as **gram atomic mass.**

e.g.,

Gram atomic mass of hydrogen = 1g

Gram atomic mass of carbon = 12g

Gram atomic mass of nitrogen = 14g

Gram atomic mass of oxygen = 16g

Gram atomic mass of sodium = 23g

Atomic mass is expressed in atomic mass unit (**amu**). **One atomic mass unit is defined as 1/12th part of the mass of one atom of carbon.**

10.5. RELATIVE MOLECULAR MASS(RMM)

10.5.1. Definition (based on hydrogen scale)

$$RMM = \frac{\text{Mass of 1 molecule of an element / compound}}{\text{Mass of 1 atom of hydrogen}}$$

The relative molecular mass of an element or a compound is the ratio of mass of one molecule of the element or a compound to the mass of one atom of hydrogen.

10.5.2. Definition (based on carbon scale)

$$RMM = \frac{\text{Mass of 1 molecule of an element / compound}}{\frac{1}{12}\text{ th part of the mass of one atom of carbon}}$$

The relative molecular mass of an element or a compound is the ratio of mass of one molecule of the element or a compound to the mass of 1/12 th part of mass of one atom of carbon.

Relative molecular mass is a pure ratio and has no unit. If the molecular mass of a given substance is expressed in gram, it is known as **gram molecular mass** of that substance.

Molecular mass is the sum of atomic masses.

Gram molecular mass calculations to test your numerical skill

1. Find the gram molecular mass of water (H_2O)

calculation

$$2(H) = 2 \times 1 = 2$$
$$1(O) = 1 \times 16 = \underline{16}$$
$$\underline{18}$$

$\therefore$ **Gram molecular mass of H_2O = 18g**

2. Find the gram molecular mass of carbon dioxide (CO_2)

$$1(C) = 1 \times 12 = 12$$
$$2(O) = 2 \times 16 = \underline{32}$$
$$44$$

Gram molecular mass of CO_2 = 44 g

10.6. MOLE CONCEPT

While performing a reaction, to know the number of atoms (or) molecules involved, the **concept of mole** was introduced. The quantity of a substance is expressed in terms of mole.

Shown here in Fig.10.3 are one mole quantities of each of the following materials: (clockwise from top left) 180g of acetylsalicylic acid (aspirin), 18.0g of water, 342g of sucrose (table sugar), 201g

Fig. 10.3 Mole in various forms

of mercury, 55.9g of iron, 58.5g of sodium chloride (table salt), and 254g of iodine.

10.6.1. Definition of mole

Mole is defined as the amount of substance that contains as many specified elementary particles as the number of atoms in 12g of carbon-12 isotope.

One mole is also defined as the amount of substance which contains Avogadro number (6.023×10^{23}) of particles.

Avogadro number: Number of atoms or molecules or ions present in one mole of a substance is called Avogadro number. Its value is 6.023×10^{23}.

Therefore, one mole of any substance contains Avogadro number of particles. The particles may be atoms, molecules, ions etc.,

For eg. one mole of oxygen atoms represents 6.023×10^{23} atoms of oxygen and 5 moles of oxygen atoms contain $5 \times 6.023 \times 10^{23}$ atoms of oxygen.

To find the number of moles, the following formulae are useful

$$\text{Number of moles} = \frac{\text{Mass}}{\text{atomic mass}}$$

$$\text{Number of moles} = \frac{\text{Mass}}{\text{molecular mass}}$$

$$\text{Number of moles} = \frac{\text{No. of atoms}}{6.023 \times 10^{23}}$$

$$\text{Number of moles} = \frac{\text{No. of molecules}}{6.023 \times 10^{23}}$$

WATCH OUT !

It may be noted that while using the term mole it is essential to specify the kind of particles involved.

10.6.2. Problems (based on mole concept)

1. *When the mass of the substance is given:*

$$\text{Number of moles} = \frac{\text{given mass}}{\text{atomic mass}}$$

a. Calculate the number of moles in

i) 81g of aluminium ii) 4.6g sodium iii) 5.1g of Ammonia iv) 90g of water v) 2g of NaOH

$$\text{Number of moles} = \frac{\text{given mass}}{\text{atomic mass}} = \frac{81}{27}$$

= 3 moles of aluminium

FOLLOW UP: Find the number of moles for remaining problems given above.

b. Calculate the mass of 0.5 mole of iron

Solution: mass = atomic mass x number of moles

= 55.9 x 0.5 = 27.95 g

FOLLOW UP: Find the mass of 2.5 mole of oxygen atoms

Mass = molecular mass x number of moles

2. *Calculation of number of particles when the mass of the substance is given:*

Number of particles =

$$\frac{\text{Avogadro number x given mass}}{\text{gram molecular mass}}$$

a. Calculate the number of molecules in 11g of CO_2

Solution: gram molecular mass of CO_2 = 44g

$$\text{Number. of molecules} = \frac{6.023 \times 10^{23} \times 11}{44}$$

= **1.51×10^{23} molecules**

FOLLOW UP: Calculate the number of molecules in 360g of glucose.

3. *Calculation of mass when number of particles of a substance is given:*

Mass of a substance

$$= \frac{\text{gram molecular mass x number of particles}}{6.023 \times 10^{23}}$$

a. Calculate the mass of 18.069×10^{23} molecules of SO_2

Sol: Gram molecular mass SO_2 = 64g

Mass of SO_2

$$= \frac{64 \times 18.069 \times 10^{23}}{6.023 \times 10^{23}} = 192 \text{ g}$$

b. Calculate the mass of glucose in 2×10^{24} molecules

Gram molecular mass of glucose = 180g

Mass of glucose

$$= \frac{180 \times 2 \times 10^{24}}{6.023 \times 10^{23}} = 597.7\text{g}$$

FOLLOW UP: Calculate the mass of 12.046×10^{23} molecules in CaO.

4. *Calculation of number of moles when you are given number of molecules:*

$$\text{Number of moles} = \frac{\text{Number of molecules}}{\text{Avogadro Number}}$$

$$= \frac{3.0115 \times 10^{23}}{6.023 \times 10^{23}} = 0.5 \text{ moles}$$

b. Calculate number of moles in 12.046×10^{22} atoms of copper

Number of moles of atoms

$$= \frac{\text{Number of atoms}}{\text{Avogadro Number}}$$

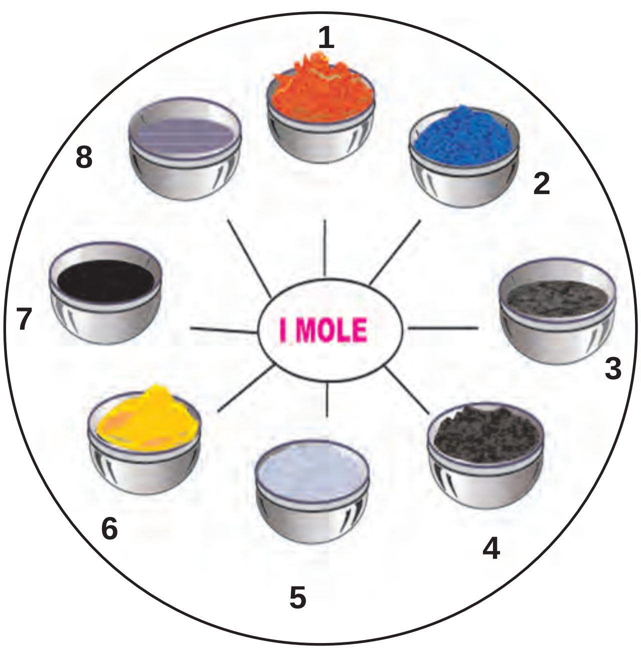
$$= \frac{12.046 \times 10^{22}}{6.023 \times 10^{23}} = 0.2 \text{ moles}$$

FOLLOW UP: Calculate the number of moles in 24.092×10^{22} molecules of water.

MORE TO KNOW

Molar volume: Volume occupied by one mole of any gas at STP is called molar volume. Its value is 22.4 litres

22.4 litres of any gas contains 6.023×10^{23} molecules.



1. 162.4 g of $FeCl_3$

2. 159.6g of $CuSO_4$

3. 27g of Al

4. 56g of Fe

5. 58.5 g of NaCl

6. 32g of S

7. 12g of C

8. 200.6g of Hg

Fig. 10.4 More illustrations for mole in various forms

EVALUATION

PART A

1. From the given examples, form the pair of isotopes and the pair of isobars

   ${}_{18}Ar^{40}$, ${}_{17}Cl^{35}$, ${}_{20}Ca^{40}$, ${}_{17}Cl^{37}$

2. Molecular mass of nitrogen is 28. Its atomic mass is 14. Find the atomicity of nitrogen.
3. Gram molecular mass of oxygen is 32g. Density of oxygen is 1.429g/cc. Find the gram molecular volume of oxygen.
4. 'Cl' represents chlorine atom, 'Cl_2' represents chlorine molecule.

   List out any two differences between atoms and molecules.

5. Calculate the gram molecular mass of water from the values of gram atomic mass of hydrogen and of oxygen.

   Gram atomic mass of hydrogen = 1g

   Gram atomic mass of oxygen = 16g

6. One mole of any substance contains 6.023×10^{23} particles.

   If 3.0115×10^{23} particles are present in CO_2. Find the number of moles.

PART B

1. Modern atomic theory takes up the wave concept, principle of uncertainty and other latest discoveries to give a clear cut picture about an atom. State the findings of modern atomic theory.
2. You are given the values of mass of one volume of oxygen gas and the mass of one volume of hydrogen. By applying Avagadro's law how will you establish the relation between vapour density and molecular mass of a gas?
3. Calculate the number of moles in
   a. 12.046×10^{23} atoms of copper
   b. 27.95g of iron
   c. 1.51×10^{23} molecules of CO_2

FURTHER REFERENCE :

BOOKS: 1. Physical Chemistry : **Puri and sharma - Vishal publications**

2. Inorganic Chemistry : **P.L. Soni - S.Chand publication**

WEBSITE : www.ehow.com/atomsandmolecules

www.chem4kids.com/tag/atomsandmolecules

Chapter 11

CHEMICAL REACTIONS

11. Chemical Reactions

All living beings born in this beautiful world have their own life styles. Have you observed and analyzed your daily life from the view point of a chemist? Chemical reactions happen around us all the time and even in our body.

Any change can be classified as physical change and chemical change. Physical changes can be easily reversed but, it is not easy to reverse a chemical change. What is the reason? In chemical changes, new substances are formed and it is difficult to regenerate the original substances. Chemical changes are more permanent than physical changes. All chemical changes are accompanied by chemical reactions.

How do we come to know that a chemical reaction has taken place? Let us perform some activities to find out the answer to this question.

ACTIVITY 11.1

- Look at the new silver anklet of your mother or sister
- Note the colour of the anklet
- Observe the colour of an old anklet
- What change do you observe?

The lustrous white colour of the silver anklet slowly changes into slightly black colour. That is, silver anklet has got

Fig. 11.1 Silver Anklet

tarnished. Can you guess the reason behind it?

It is due to the formation of silver sulphide (Ag_2S), as a result of the reaction between silver and hydrogen sulphide in the air.

ACTIVITY 11.2

- Take lead nitrate solution in a beaker
- Take potassium iodide solution in a test tube.(Both solutions are colourless)
- Add potassium iodide solution slowly to the lead nitrate solution
- What do you observe?

You observe a deep yellow precipitate, don't you?

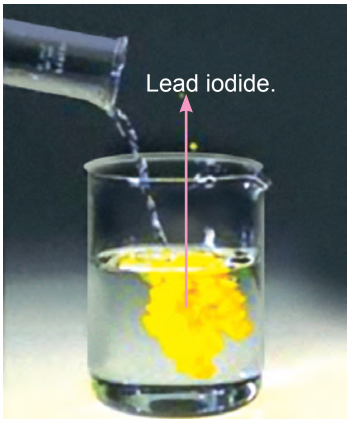


Fig. 11.2 Yellow precipitate of lead iodide.

It is lead iodide (PbI_2).

ACTIVITY 11.3

- Take 5g of calcium oxide (quick lime) in a beaker
- Add water to it slowly
- Touch the beaker
- What do you feel?

Do you feel hot? Let us see what happens.

Calcium oxide reacts with water to produce slaked lime (calcium hydroxide). This reaction is exothermic and will be accompanied by hissing sound and bubbles leading to the release of considerable amount of heat.

ACTIVITY 11.4

- Take a pinch of calcium carbonate powder in a test tube
- Add dilute hydrochloric acid
- Note the changes in the test tube carefully

Do you observe any brisk effervescence? It is due to the evolution of carbon dioxide gas.

Fig. 11.3 Reaction of calcium carbonate with dil.HCl

These are some of the common observations in a chemical reaction. From the activities that we have discussed, it is clear that chemical reactions will bring about a permanent change resulting in the formation of new product(s).

The substances taking part in the reaction are known as reactants and those formed as a result of the reaction are called products.

MORE TO KNOW

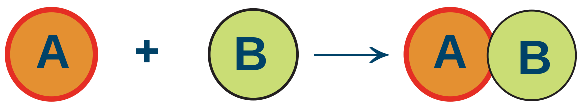
A solution of slaked lime produced in the Activity 11.3 is used for white washing. Calcium hydroxide reacts slowly with carbon dioxide in air to form a thin layer of calcium carbonate on the walls. Calcium carbonate is formed after two to three days of white washing and gives a shiny finish to the walls. It is interesting to note that the chemical formula for marble is also $CaCO_3$.

11.1. TYPES OF CHEMICAL REACTIONS

Since there are numerous chemical reactions, the study of these reactions can be made easier by classifying them. All the chemical reactions are classified into six broad categories depending on the way the product formed.

Let us see the different types of classifications of chemical reactions.

1. COMBINATION REACTION



A combines with **B** to form a new product **AB**. It is the simple representation of combination reaction.

ACTIVITY 11.5

- Take a clean piece of magnesium ribbon
- Hold the ribbon with a pair of tongs
- Burn it in air using a burner (keeping Mg ribbon as far as possible from your eyes)
- Collect the ash

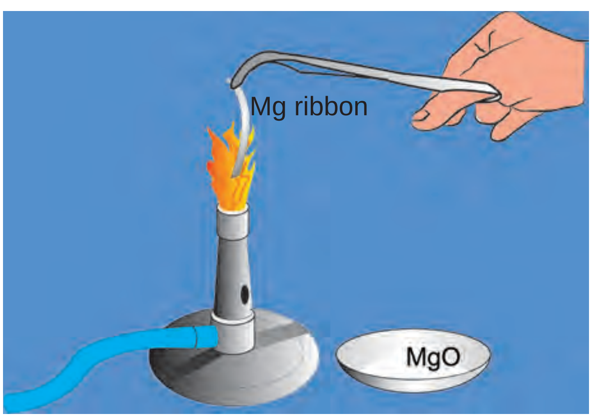


Fig. 11.4 Burning of Mg ribbon

In the above activity, magnesium combines with oxygen to form a single product, magnesium oxide. **Such a reaction in which a single product formed from two or more reactants is known as combination reaction.**

$$2Mg + O_2 \rightarrow 2MgO$$

Repeat "**Activity 11.3**". This reaction is also an example for COMBINATION REACTION. Attempt to write the equation yourself.

Let us discuss some more examples of combination reactions.

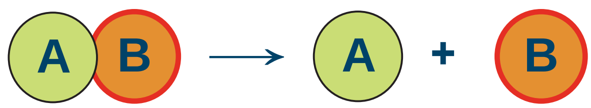
- Combustion of coal

$$C + O_2 \rightarrow CO_2$$

- Combustion of hydrogen

$$2H_2 + O_2 \rightarrow 2H_2O$$

2 DECOMPOSITION REACTION



AB splits into **A** and **B.** It is the representation of decomposition reaction.

ACTIVITY 11.6

- Take about 2 g of copper carbonate powder in a dry test tube
- Note the colour of copper carbonate
- Heat the test tube over the flame
- Observe the change after heating

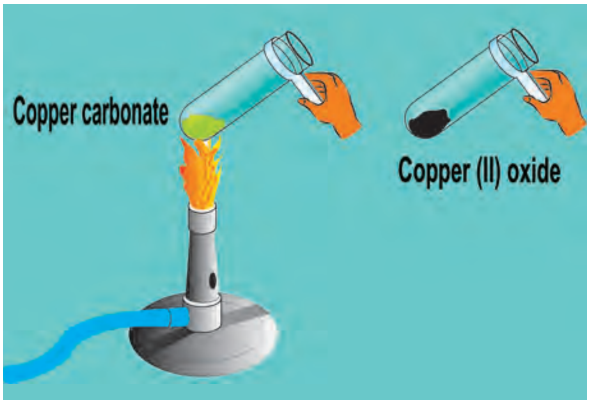


Fig. 11.5 Heating the test tube containing copper carbonate

Change of colour from green to black is observed. This is due to the decomposition of copper carbonate to copper (II) oxide.

$$CuCO_3 \xrightarrow{\Delta} CuO + CO_2\uparrow$$

ACTIVITY 11.7

- Take lead nitrate in a test tube
- Heat it over the flame
- Observe the changes

Liberation of a reddish brown gas (NO_2) is observed. This is because of the decomposition of lead nitrate into lead oxide, nitrogen dioxide and oxygen.

$$2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2\uparrow + O_2\uparrow$$

From the above two activities (11.6 and 11.7), It can be noted that a **single compound breaks down to produce two or more substances. Such type of reaction is called decomposition reaction.**

Some other examples for decomposition reaction:

1. Decomposition of lime stone

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2\uparrow$$

2. Decomposition of ammonium dichromate

$$(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} Cr_2O_3\uparrow + N_2\uparrow + 4H_2O\uparrow$$

MORE TO KNOW

At very high temperature,ammonium dichromate decomposes immediately to green vapours which gets released along with the steam. It seems as if a volcano erupts and is termed as chemical volcano.

3. DISPLACEMENT REACTION

$$A + BC \longrightarrow AC + B$$

In the reaction between **A** and **BC, A** displaces **B** from **BC** to form **AC**. This shows that A is more reactive than **B**.

ACTIVITY 11.8

- Take 20 ml of copper sulphate solution in a beaker
- Drop an iron nail into the beaker
- Leave it for few days
- Observe the colour of the copper sulphate solution and the iron nail

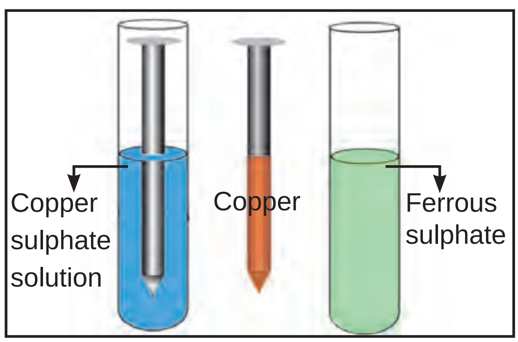


Fig. 11.6 Iron displaces copper from copper sulphate solution

Blue colour of the copper sulphate solution changes into green colour and the iron nail acquires a brownish look. It is a noticeable change. Is it not? This change confirms that iron is more reactive than copper. The following chemical reaction takes place in this activity.

$$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$$

In this reaction, iron displaces copper from $CuSO_4$ solution.

Repeat "**Activity 11.8**" but use zinc rod instead of an iron nail. What colour changes do you observe on the rod and in the solution? Write the chemical equation.

Other example:

$$Pb + CuCl_2 \rightarrow PbCl_2 + Cu$$

Lead can displace copper from its salt solutions. Can copper displace zinc or lead from their salt solutions? No, because copper is less reactive than zinc and lead.

The reaction in which, a more reactive element displaces a less reactive element from its compound is called displacement reaction.

4. DOUBLE DECOMPOSITION REACTION (DOUBLE DISPLACEMENT REACTION)

In the reaction between **AB** and **CD**, both the reactants decompose to form **AD** and **CB** through the rearrangement of ions.

ACTIVITY 11.9

- Take 5ml of sodium sulphate solution in a test tube
- In another test tube, take 5ml of barium chloride
- Mix both the solutions
- What do you observe?

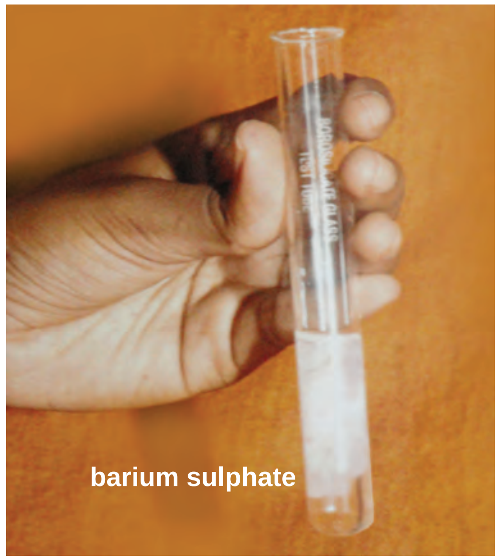


Fig. 11.7 Formation of barium sulphate

You will observe formation of a white substance, which is insoluble in water. The insoluble substance formed is known as *precipitate*. Any reaction that produces a precipitate is called a **precipitation reaction.** The formed white precipitate of barium sulphate, is due to the reaction of SO_4^{2-} and Ba^{2+} ions. The other product formed is sodium chloride.

$$Na_2SO_4 + BaCl_2 \rightarrow BaSO_4\downarrow + 2NaCl$$

Repeat **"Activity 11.2"** for double decomposition reaction. Attempt to write the equation by yourself.

Double decomposition reaction is any reaction in which exchange of ions between two reactants occur, leading to the formation of two different products.

Other example :

$$CuSO_4 + H_2S \rightarrow CuS\downarrow + H_2SO_4$$

5. OXIDATION AND REDUCTION

We are all aware of the fact that oxygen is the most essential element for sustaining life. One can live without food or even water for a number of days, but not without oxygen. In our daily life we come across phenomena like fading of the colours of the clothes, burning of combustible substances like cooking gas, wood and coal, and also rusting of iron articles. All such processes fall in the category of a specific type of chemical reaction called oxidation – reduction reaction (redox reaction). A large number of industrial processes like electroplating, extraction of metals like aluminium, are based upon the redox reaction.

Oxidation:

A chemical reaction which involves addition of oxygen or removal of hydrogen or loss of electron(s) is called as oxidation.

$2Mg + O_2 \rightarrow 2MgO$ (addition of oxygen)

$H_2S + Br_2 \rightarrow 2HBr + S$ (removal of hydrogen)

$Fe^{2+} \rightarrow Fe^{3+} + e^-$ (loss of electron)

Reduction:

A chemical reaction which involves addition of hydrogen or removal of oxygen or gain of electron(s) is called as reduction.

$2Na + H_2 \rightarrow 2NaH$ (addition of hydrogen)

$CuO + H_2 \rightarrow Cu + H_2O$ (removal of oxygen)

$Fe^{3+} + e^- \rightarrow Fe^{2+}$ (gain of electron)

Redox reaction:

A chemical reaction in which oxidation and reduction take place simultaneously is called redox reaction.

$$Zn + CuSO_4 \rightarrow Cu + ZnSO_4$$

Attempt to write any other redox reaction

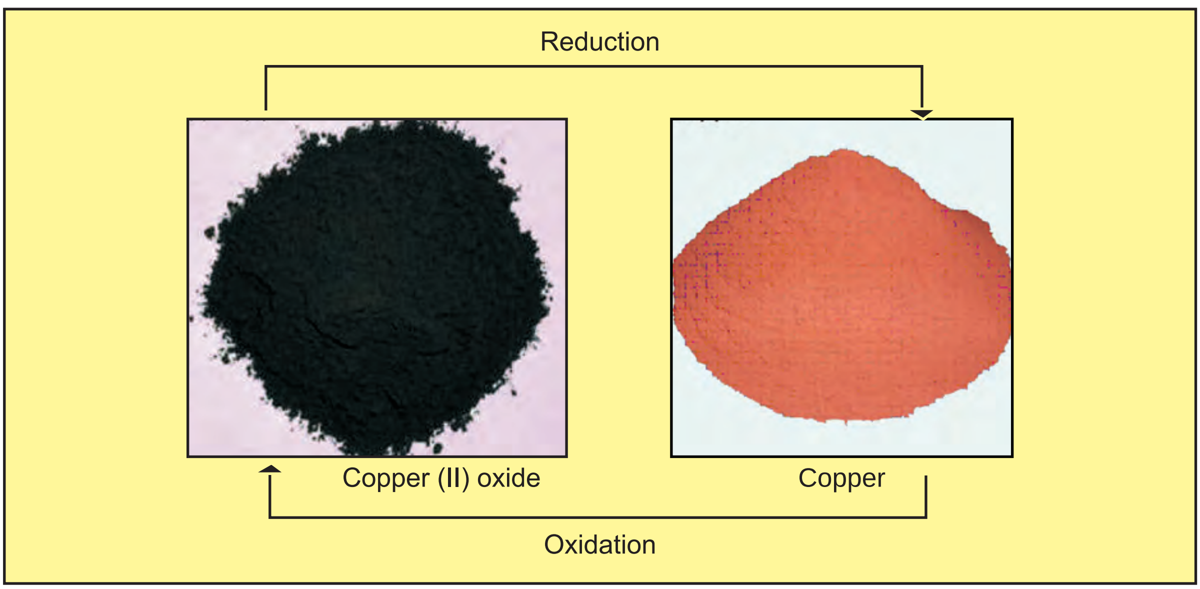


Fig. 11.8 Redox reaction

During the conversion of copper(II) oxide to copper, the copper(II) oxide is losing oxygen and is being reduced. The hydrogen is gaining oxygen and is being oxidised. In other words, one reactant gets oxidised while the other gets reduced during the reaction. Such reactions are called oxidation – reduction reactions or redox reactions.

Oxidation is	**Reduction is**
Gain of oxygen Loss of hydrogen Loss of electron(s)	Loss of oxygen Gain of hydrogen Gain of electron(s)
Oxidation and reduction always takes place together, so the reaction is called redox reaction.	

DON'T FORGET

Loss of electron is oxidation.

Gain of electron is reduction.

The term LEO, GER will help you to remember.

MORE TO KNOW

Oxidation also has damaging effects on food and eatables. When food containing fat and oil is left as such for a long time, it becomes stale. The stale food develops bad taste and smell. This is very common in curd or cheese particularly in summer. Oils and fats are slowly oxidised to certain bad smelling compounds.

6. EXOTHERMIC AND ENDOTHERMIC REACTIONS

During chemical reactions one of the most common change is a change in temperature. When detergent is dissolved in water to wash clothes, heat is given out. When glucose is kept on our tongue, a chilling effect is felt. During these processes, heat is either given out or absorbed from the surroundings. In the same way, in most of the chemical reactions, energy is either taken up or given out.

a. Exothermic reactions

The chemical reactions which proceed with the evolution of heat energy are called exothermic reactions.

$$N_2 + 3H_2 \rightarrow 2NH_3 + \text{Heat}$$

All combustion reactions are exothermic. Heat energy is liberated as the reaction proceeds.

b. Endothermic reactions

The chemical reactions which proceed with the absorption of heat energy are called endothermic reactions.

$$2NH_3 + \text{Heat} \rightarrow N_2 + 3H_2$$

11.2 RATE OF THE CHEMICAL REACTION

Rate of the chemical reaction is defined as change in concentration of any one of the reactants or products per unit time.

Consider the reaction

$$A \rightarrow B$$

Rate of the reaction is given by

$$\text{Rate} = -\frac{d[A]}{dt} = +\frac{d[B]}{dt}$$

[A] - concentration of reactant A

[B] - concentration of product B

- ve sign indicates decrease in con centration of A with time.

+ ve sign indicates increase in concentration of B with time.

11.2.1 FACTORS INFLUENCING THE RATE OF THE CHEMICAL REACTION

1. NATURE OF THE REACTANTS

ACTIVITY 11.10

- Take magnesium ribbon in two test tubes A and B
- Add hydrochloric acid to test tube A
- Add acetic acid to test tube B
- Observe the changes in two test tubes

Magnesium ribbon reacts with both hydrochloric acid and acetic acid but reaction is faster in hydrochloric acid than in acetic acid. Do you know why? Hydrochloric acid is more reactive than acetic acid. It shows that **nature of the reactant influences the rate of the reaction**.

2. CONCENTRATION OF THE REACTANTS

ACTIVITY 11.11

- Take 3g of granulated zinc in the test tube A and B
- Add 5 ml of 1 M hydrochloric acid in test tube A
- Add 5 ml of 2 M hydrochloric acid in test tube B
- Observe the changes

Granulated zinc reacts with both 1M hydrochloric acid and 2M hydrochloric acid, the rate of evolution of hydrogen gas is more from the test tube B than from the test tube A. This is because, 2M hydrochloric acid is more concentrated than 1M hydrochloric acid. That is, **greater the concentration of the reactant, greater will be the rate of the reaction.**

3. SURFACE AREA OF THE REACTANTS

ACTIVITY 11.12

- Take powdered calcium carbonate in beaker A
- Take marble chips (calcium carbonate) in beaker B
- Add hydrochloric acid in both beakers A and B
- Observe the changes

Powdered calcium carbonate reacts more quickly with hydrochloric acid than marble chips. What is the reason?.

Powdered calcium carbonate offers large surface area for the reaction to occur at a faster rate. **This shows that greater the surface area, greater is the rate of the reaction.**

4. TEMPERATURE

ACTIVITY 11.13

- Take 3g of marble chips in a beaker
- Add 5 ml of 1M hydrochloric acid
- Observe the changes
- Heat the beaker
- Observe the changes

Calcium carbonate present in marble chips react slowly with hydrochloric acid at room temperature and evolves carbon dioxide at slower rate, whereas on heating, the evolution of carbon dioxide is made faster. **This shows that increase in temperature increases the rate of the reaction.**

5. CATALYST

ACTIVITY 11.14

- Take potassium chlorate in a test tube
- Heat the test tube
- Observe what happens
- Add manganese dioxide as a catalyst
- Observe the changes

When potassium chlorate is heated, oxygen is evolved very slowly whereas after the addition of manganese dioxide to the reactant, oxygen is liberated at a faster rate. **This shows that manganese dioxide acts as a catalyst and influences the rate of the reaction.**

GROUP ACTIVITY

- From dawn to dusk observe any 10 chemical changes taking place around you and classify them
- Prepare volcano using ammonium dichromate (vigorous)
- Prepare volcano using baking soda (silent)

MORE TO KNOW

A substance which alters the rate of the reaction without undergoing any change in mass and composition is known as catalyst.

ACIDS, BASES AND SALTS

Nivi : Hai Vini, you look tired. Take this fresh lime juice.

Vini : No, it has sour taste.

Nivi : Do you know why is it sour?

Vini : Sorry, I have no idea at all.

Nivi : It is due to the presence of acid. Ok let's get set to learn about this.

Acids, bases and salts are used in everyday life. Let it be a fruit juice or a detergent or a medicine. They play a key role in our day-to-day activities. Our body metabolism is carried out by means of hydrochloric acid secreted in our stomach.

11.3. ACIDS

Acid is a substance which furnishes H^+ ions or H_3O^+ ions when dissolved in water. Acids have one or more replacable hydrogen atoms. The word acid is derived from the Latin name 'acidus' which means sour taste. Substances with 'sour taste' are acids. Lemon juice, vinegar and grape juice have sour taste, so they are acidic. They change blue litmus to red. They are

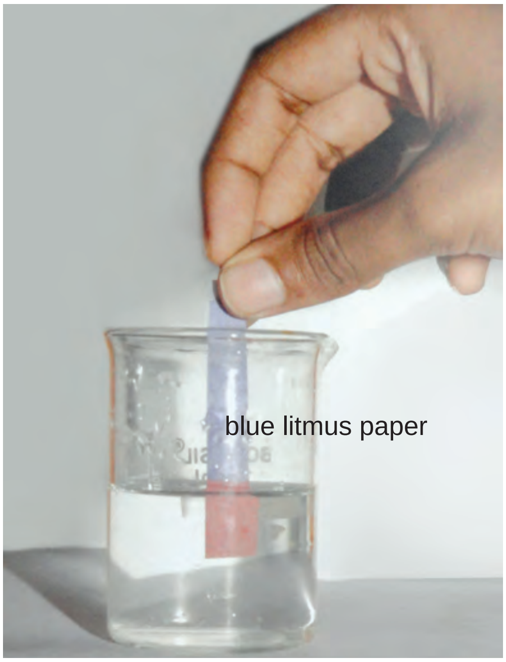


Fig. 11.9 Acid solution turns blue litmus paper red

colourless with phenolphthalein and pink with methyl orange. Many organic acids are naturally present in food items.

Source	Acid present
Apple	Malic acid
Lemon	Citric acid
Grape	Tartaric acid
Tomato	Oxalic acid
Vinegar (food preservative)	Acetic acid
Curd	Lactic acid

What is the acid present in it?

11.3.1 CLASSIFICATION OF ACIDS

1. **Based on their sources :** Acids are classified into two types namely organic acids and inorganic acids.

   Organic acids:- Acids present in plants and animals (living beings) are **organic acids** eg. HCOOH, CH_3COOH (Weak acids).

   Inorganic acids:- Acids from rocks and minerals are **inorganic acids** or mineral acids eg. HCl, HNO_3, H_2SO_4 (Strong acids).

2. **Based on their basicity**

   Monobasic acid: - It is an acid which gives one hydrogen ion per molecule of the acid in solution eg. HCl, HNO_3.

   Dibasic acid:- It is an acid which gives two hydrogen ions per molecule of the acid in solution e.g., H_2SO_4, H_2CO_3.

   Tribasic acid:- It is an acid which gives three hydrogen ions per molecule of the acid in solution. e.g.,H_3PO_4,

MORE TO KNOW

For acids, we use the term basicity which means the number of replaceable hydrogen atoms present in one molecule of an acid. For example acetic acid has four hydrogen atoms but only one can be replaced. Hence it is monobasic.

3. Based on ionisation

Acids are classified into two types based on ionisation.

Strong acids:- These are acids which ionise completely in water eg.HCl

Weak acids:-These are acids which ionise partially in water eg. CH_3COOH

4. Based on concentration:- Depending on the percentage or amount of acid dissolved in water acids are classified into concentrated acid and dilute acid.

Concentrated acid:- It is an acid having a relatively high percentage of acid in its aqueous solution.

Dilute acid:- It is an acid having a relatively low percentage of acid in aqueous solution.

MORE TO KNOW

Care must be taken while mixing any concentrated mineral acid with water. The acid must always be added slowly to water with constant stirring. If water is added to a concentrated acid the large amount of heat is generated which may cause burns. The mixture splashes out of the container.

11.3.2 CHEMICAL PROPERTIES OF ACIDS

1 REACTION OF METALS WITH ACID

ACTIVITY 11.15

- Take 5 g of zinc granules in a test tube
- Add 10 ml of dilute hydrochloric acid through thistle funnel
- During the course of addition, what do you observe?

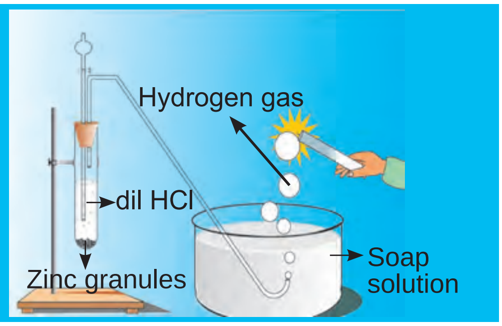


Fig. 11.10 Reaction of Zn granules with dilute HCl

Note that zinc reacts with dilute hydrochloric acid to form zinc chloride and hydrogen gas.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2\uparrow$$

When a burning candle is brought near the bubble containing hydrogen gas, the flame goes off with a '**pop**'ing sound. This confirms that metal displaces hydrogen from the dilute acid. (Hydrogen gas burns with a '**pop**'ing sound)

Metal + Acid → Salt + Hydrogen

Another example

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2\uparrow$$

MORE TO KNOW

- All metals do not liberate hydrogen gas on reaction with acids. eg., Ag,Cu.
- Lime stone, chalk and marble are different physical forms of calcium carbonate. They react with acids giving corresponding salt, carbon dioxide and water.

2. REACTION OF METAL CARBONATE AND METAL BICARBONATE WITH ACIDS

ACTIVITY 11.16

- Take two test tubes, label them as I and II
- Take small amount of washing soda (Na_2CO_3) in test tube I and small amount of baking soda ($NaHCO_3$) in test tube II
- Add dilute hydrochloric acid to both the test tubes
- What do you observe?
- Pass the gas produced in each case, through lime water [$Ca(OH)_2$] solution and record your observations

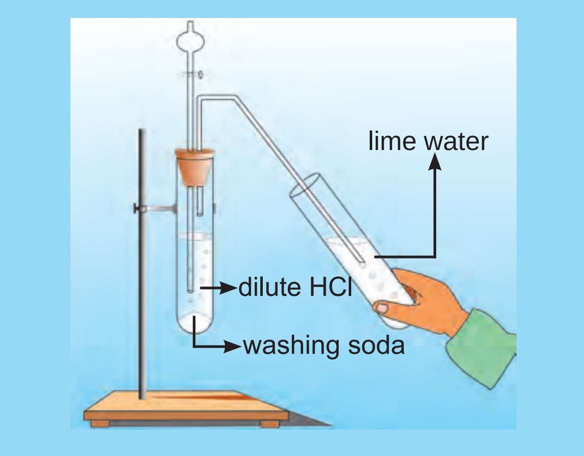


Fig. 11.11 Testing of carbon dioxide

Test tube I

$$Na_2CO_3 + 2\ HCl \rightarrow 2\ NaCl + H_2O + CO_2\uparrow$$

Test tube II

$$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2\uparrow$$

When carbon dioxide is passed through lime water, it turns milky.

$$Ca(OH)_2 + CO_2 \rightarrow \underset{\text{(milky)}}{CaCO_3} + H_2O$$

From the above activity the reaction can be summarized as

$$\begin{array}{c} \text{Metal carbonate} \\ \text{or} \\ \text{Metal bicarbonate} \end{array} + \text{Acid} \longrightarrow \begin{array}{c} \text{Salt} \\ + \\ \text{Water} \\ + \\ \text{Carbon dioxide} \end{array}$$

Other examples

$$MgCO_3 + 2\ HCl \rightarrow MgCl_2 + H_2O + CO_2\uparrow$$

$$Mg(HCO_3)_2 + 2\ HCl \rightarrow MgCl_2 + 2H_2O + 2CO_2\uparrow$$

MORE TO KNOW

Since metal carbonates and metal bicarbonates are basic they react with acids to give salt and water with the liberation of carbon dioxide.

3. REACTION OF METALLIC OXIDES WITH ACIDS

ACTIVITY 11.17

- Take about 2g copper (II) oxide in a watch glass and add dilute hydrochloric acid slowly
- Note the colour of the salt
- What has happened to the copper (II) oxide?

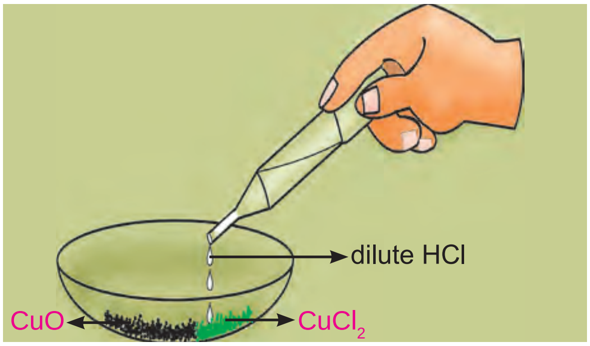


Fig. 11.12 Reaction of copper(II) oxide with dilute hydrochloric acid

The colour changes from **black to green.** This is due to the formation of copper (II) chloride in the reaction. Since metal oxides are basic, they react with acid to form salt and water.

$$CuO + 2HCl \rightarrow CuCl_2 + H_2O$$

From the above activity we conclude that

Metallic oxide + Acid → Salt + Water

Another example

$$CaO + 2HCl \rightarrow CaCl_2 + H_2O$$

4 . ACTION OF ACIDS WITH WATER.

An acid produces hydrogen ions in water.

$$HCl + H_2O \rightarrow H_3O^+ + Cl^-$$

Hydrogen ions cannot exist alone, but they exist in the form of hydronium (H_3O^+) ions with water. When water is absent, the separation of hydrogen ions from an acid does not occur.

11.3.3. USES OF ACIDS

1. Sulphuric acid (King of chemicals) is used in car battery and in the preparation of many other compounds.
2. Nitric acid is used in the production of ammonium nitrate which is used as fertilizer in agriculture.
3. Hydrochloric acid is used as cleansing agent in toilet.
4. Tartaric acid is a constituent of baking powder.
5. Salt of benzoic acid (sodium benzoate) is used in food preservation.
6. Carbonic acid is used in aerated drinks.

MORE TO KNOW

The atmosphere of Venus is made up of thick white and yellowish clouds of sulphuric acid. Do you think life can exist on this planet?

11.4. BASES

Base is a substance which releases hydroxide ions when dissolved in water. It is a substance which is bitter in taste and soapy to touch (e.g. Washing soda, caustic soda and caustic potash). They change red litmus to blue. They are pink with phenolphthalein and yellow with methyl orange.

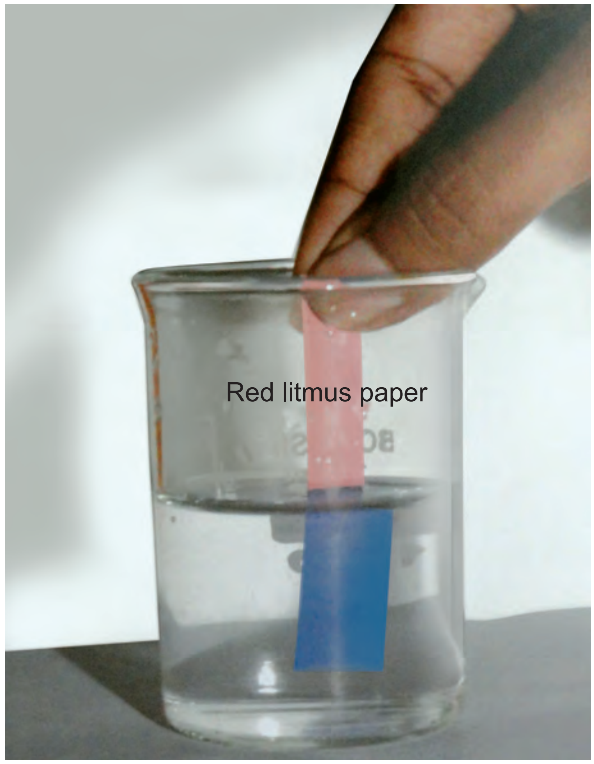


Fig. 11.13 Bases turns red litmus paper blue

11.4.1. Classification of bases

1. **Based on ionisation**

   Strong bases:- These are bases which ionise completely in aqueous solution eg.NaOH, KOH.

   Weak bases:- These are bases which ionise partially in aqueous solution eg. NH_4OH, $Ca(OH)_2$.

2. **Based on their acidity**

   Monoacidic base:- It is a base which ionises in water to give

one hydroxide ion per molecule eg.NaOH, KOH.

Diacidic base:- It is a base which ionises in water to give two hydroxide ions per molecule eg. $Ca(OH)_2$, $Mg(OH)_2$.

Triacidic base:- It is a base which ionises in water to give three hydroxide ions per molecule eg. $Al(OH)_3$, $Fe(OH)_3$.

MORE TO KNOW

The term acidity is used for base which means the number replaceable hydroxyl groups present in one molecule of a base.

3. **Based on the concentration:**
Depending on the percentage or amount of base dissolved in water, bases are classified as concentrated alkali and dilute alkali.

Concentrated alkali:- It is an alkali having a relatively high percentage of alkali in its aqueous solution.

Dilute alkali:- It is an alkali having a relatively low percentage of alkali in its aqueous solution.

MORE TO KNOW

Bases which dissolve in water are called alkalies. All alkalies are bases, but not all bases are alkalis. NaOH and KOH are alkalies whereas $Al(OH)_3$ and $Zn(OH)_2$ are bases.

11.4.2. Chemical Properties of Bases

1. REACTION OF BASE WITH METALS

Zinc reacts with sodium hydroxide to form sodium zincate with the liberation of hydrogen gas.

$$Zn + 2\,NaOH \rightarrow Na_2ZnO_2 + H_2\uparrow$$

Metal + Base → Salt + Hydrogen

Another example

$$2\,Al + 2\,NaOH + 2\,H_2O \rightarrow 2\,NaAlO_2 + 3\,H_2\uparrow$$

MORE TO KNOW

All metals do not react with sodium hydroxide eg. Cu, Ag, Cr

2. REACTION OF NON METALLIC OXIDES WITH BASES

Sodium hydroxide reacts with carbon dioxide gives sodium carbonate and water.

$$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$$

The above reaction confirms that

Non metallic oxide + Base → Salt + Water

Another example

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

3. ACTION OF BASES WITH WATER

Bases generate hydroxide (OH^-) ions when dissolved in water.

$$NaOH \rightarrow Na^+ + OH^-$$

4. REACTION OF ACIDS WITH BASES

ACTIVITY 11.18

- Indira takes 20 ml of 0.1N sodium hydroxide solution in a conical flask and adds few drops of phenolphthalein.
- What colour does she observe?
- She is adding 20 ml of 0.1N hydrochloric acid solution to the above conical flask drop by drop.
- Does she observe any colour change in the reaction mixture?

In the above activity, Indira observed that the effect of a base is nullified by an acid.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

The above reaction between an acid and a base is known as neutralisation reaction.

Acid + Base → Salt + Water

Fig. 11.14 Reaction of sodium hydroxide with hydrochloric acid

11.4 USES OF BASES

1. Sodium hydroxide is used in the manufacture of soap.
2. Calcium hydroxide is used in white washing the buildings.
3. Magnesium hydroxide is used as a medicine for stomach troubles.
4. Ammonium hydroxide is used to remove grease stains from clothes.

11.5 IDENTIFICATION OF ACIDS AND BASES

ACTIVITY 11.19

- Collect lemon juice, washing soda solution, soap solution and soft drinks.
- Take 2 ml of each solution in a test tube and test with a litmus paper or indicator.
- What change in colour do you observe with red litmus, blue litmus, phenolphthalein and methyl orange?
- Tabulate your observations.

Sample solution	Red litmus	Blue litmus	Phenolphthalein	Methyl orange
Lemon Juice				
Washing soda Solution				
Soap solution				
Soft drinks				

Same activity can be repeated for dilute hydrochloric acid, dilute sulphuric acid, sodium hydroxide solution and potassium hydroxide solution with the help of your teacher.

INDICATOR	COLOUR IN ACID	COLOUR IN BASE
Litmus	Red	Blue
Phenolphthalein	Colourless	Pink
Methyl orange	Red	Yellow

11.6 pH SCALE

pH stands for the power of hydrogen ion concentration in a solution. pH values decide whether a solution is acidic or basic or neutral. pH scale was introduced by S.P.L. Sorenson. It is mathematically expressed as

$pH = -log_{10}[H^+]$

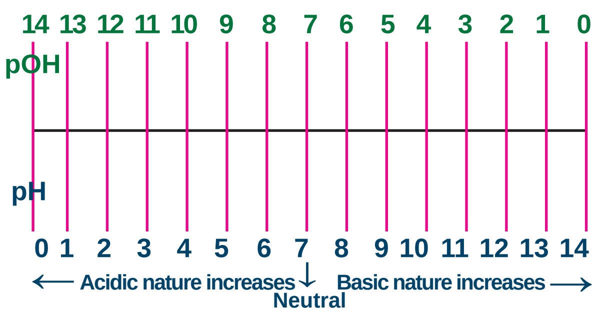
For neutral solution $[H^+] = 10^{-7}M$; pH = 7

For acidic solution $[H^+] > 10^{-7}M$; pH < 7

For basic solution $[H^+] < 10^{-7}M$; pH > 7

When OH^- ions are taken into account the pH expression is replaced by pOH

$pOH = -log_{10}[OH^-]$



Problems

1. The hydrogen ion concentration of a solution is 0.001M. What is the pH of the solution?

Solution

$pH = -log_{10}[H^+]$

$pH = -log_{10}(0.001)$

$pH = -log_{10}(10^{-3})$

$= -(-3)\,log_{10}10$ $\quad$ [log 10 = 1]

pH = 3

2. The hydrogen ion concentration of a solution is 1.0×10^{-9} M. What is the pH of the solution? Predict whether the given solution is acidic, basic or neutral.

Solution

$pH = -log_{10}[H^+]$

$pH = -log_{10}(1.0 \times 10^{-9})$

$pH = -(log_{10}1.0 + log_{10}10^{-9})$ [$log_{10}1 = 0$]

$= -(0-9\,log_{10}10)$

$pH = -(0-9) = 9$

pH = 9 ie pH >7

Therefore the given solution is basic.

3. The hydroxyl ion concentration of a solution is 0.001M. What is the pH of the solution?

Solution

$pOH = -log_{10}[OH^-]$

$pOH = -log_{10}(10^{-3})$

pOH = 3

pH = 14 – pOH

pH = 14 – 3 = 11

pH + pOH = 14
pH = 14 – pOH

4. The hydroxyl ion concentration of a solution is 1.0×10^{-9} M. What is the pH of the solution?

Solution

$pOH = -log_{10}[OH^-]$

$pOH = -log_{10}(1.0 \times 10^{-9})$

pOH = 9

pH = 14 – pOH

pH = 14 – 9 = 5

11. 6.1 pH paper

A more common method of measuring pH in a school laboratory is by using pH paper. pH paper contains a mixture of indicators, which gives different colours across the entire pH range. pH value of the various solutions are given in the table.

$$pH = -\log_{10}[H^+]$$

$$pH = \log_{10}\left[\frac{1}{H^+}\right]$$

$$[H^+] = 10^{-pH}$$

$$[H^+] = 1 \times 10^{-7}\ ;\ pH = 7$$

$$[H^+] = 1 \times 10^{-2}\ ;\ pH = 2$$

$$[H^+] = 1 \times 10^{-14}\ ;\ pH = 14$$

Solution	Approximate pH
Lemon juice	2.2 – 2.4
Tomato juice	4.1
Coffee	4.4 - 5.5
Human saliva	6.5 - 7.5
House hold ammonia	12.0

Fig. 11.15 pH paper

ACTIVITY 11.20

- Take lemon juice, orange juice, 1M NaOH, 1M HCl, pure water and vinegar
- Dip pH paper into these solutions
- Observe the changes

Sl. No.	Sample	Colour of pH paper	Approximate pH	Nature of substance
1.	Lemon juice			
2.	Orange juice			
3.	1M NaOH			
4.	1M HCl			
5.	Pure H_2O			
6.	Vinegar			

11.6.2 Importance of pH in everyday life

1. pH in human body

(i) Using pH factor the healthiness of our body is predicted. At pH level 6.9, the body becomes prone to viral infections like colds, cough and flu. Cancer cells thrive inside the body at a pH of 5.5.

(ii) The pH of a normal, healthy human skin is 4.5 to 6. Proper skin pH is essential for a healthy complexion.

(iii) pH of stomach fluid is approximately 2.0. This fluid is essential for the digestion of food.

(iv) Human blood pH range is 7.35 to 7.45. Any increase or decrease in this value, leads to diseases. The ideal pH for blood is 7.4.

(v) pH of normal saliva ranges between 6.5 to 7.5.

(vi) White enamel coating in our teeth is calcium phosphate, hardest substance in our body. It does not dissolve in water. If pH of mouth falls below 5.5, the enamel gets corroded. Toothpastes are generally basic, and is used for cleaning the teeth, can neutralize the excess acid and prevent tooth decay.

2. pH in soil

In agriculture, the pH of soil is very important. Citrus fruits require slightly alkaline soil, while rice requires acidic soil and sugar cane requires neutral soil.

3. pH in rain water

pH of rain water is approximately 7 showing high level of its purity and neutrality. If rain water is polluted by SO_2 and NO_2, acid rain occurs, bringing the pH value less than 7.

11.7 SALT

When you say salt, you may think of white stuff put on chips. But that is just one salt called common salt. There are many other salts used in other fields. Salts are the products of the reaction between acids and bases (see reaction of acids and bases), which produce positive ions and negative ions when dissolved in water.

11.7.1 Classification of salts

1. Normal salts

A normal salt is obtained by complete neutralization of an acid by a base

$$NaOH + HCl \rightarrow NaCl + H_2O$$

2. Acid salts

Acid salts are derived by the partial replacement of hydrogen ions of an acid by a metal. When a calculated amount of a base is added to a polybasic acid, acid salt is obtained, as follows.

$$NaOH + H_2SO_4 \rightarrow NaHSO_4 + H_2O$$

3. Basic salts

Basic salts are formed by the partial replacement of hydroxide ions of a diacidic or triacidic base by an acid radical.

A basic salt may further reacts with an acid to give a normal salt.

$$\underbrace{Pb(OH)_2}_{\text{Diacidic base}} + HCl \rightarrow \underbrace{Pb(OH)Cl}_{\text{Basic salt}} + H_2O$$

4. Double salts

Double salts are formed by the combination of saturated solution of two simple salts in equimolar ratio followed by crystallization.

e.g. potash alum

11.7.2 USES OF SALTS

Common salt (NaCl)

It is used in our daily food and as preservative.

Washing soda (Na_2CO_3)

1. It is used in softening hard water.
2. It is used as a cleaning agent for domestic purposes.

Baking soda ($NaHCO_3$)

1. It is used in making baking powder, which is the mixture of baking soda and tartaric acid. Baking powder is used to make cake and bread soft and spongy .
2. It is an ingredient in antacid. Being alkaline, it neutralises excess of acid in the stomach.

Bleaching powder ($CaOCl_2$)

1. It is used for disinfecting drinking water to make it free from microorganisms.
2. It is used for bleaching cotton and linen in the textile industry

Plaster of paris($CaSO_4 . 1/2H_2O$)

It is used for plastering fractured bones and in making casts for statues

GROUP ACTIVITY

Prepare the following salt in the laboratory

1. Sodium chloride
2. Potash alum

EVALUATION

PART A

1. $Zn + 2HCl \rightarrow ZnCl_2 + H_2 \uparrow$

The above reaction is an example of

a) Combinationreaction
b) Double displacement reaction
c) Displacement reaction
d) Decomposition reaction.

2. A reddish brown coloured element 'X' on heating in air becomes black coloured compound 'Y'. X and Y are______ and ________(Cu, CuO / Pb, PbO).

3. A student tested the pH of pure water using a pH paper. It showed green colour. If a pH paper is used after adding lemon juice into water, what color will he observe? (Green / Red / Yellow)

4. Chemical volcano is an example of (combination reaction / decomposition reaction)

5. When crystals of lead nitrate on heating strongly produces a _____ gas and the colour of the gas is __________.

6. When aqueous solution of silver nitrate and sodium chloride are mixed _______ precipitate is immediately formed (white / yellow / red).

7. Zinc can displace aluminium metal from aqous solution of aluminium sulphate (zinc is more reactive than aluminium / aluminium is more reactive than zinc).

8. To protect tooth decay, we are advised to brush our teeth regularly. The nature of the tooth paste commonly used is _______ in nature.

9. Vinegar is present in acetic acid. Curd contains ______ acid (Lactic acid / Tartaric acid).

10. pH = - $\log_{10}$ $[H^+]$. The pH of a solution containing hydrogen ion concentration of 0.001M solution is _____(3 / 11 / 14)

PART B

11. What type of chemical reaction takes place when i) limestone is heated ii) a magnesium ribbon is burnt in air?

12. The pH values of certain familiar substances are given below.

Substance	pH value
Blood	7.4
Baking soda	8.2
Vinegar	2.5
Household ammonia	12

analyse the data in the table and answer the following questions

a) Which substance is acidic in nature?

b) Which substances are basic in nature?

13. Why does the colour of copper sulphate change when an iron nail is kept in it? Justify your answer.

14. The hydroxyl ion concentration of a solution is 1.0×10^{-8}M. What is the pH of the solution?

15. Equal lengths of magnesium ribbons are taken in test tubes A and B. Hydrochloric acid is added to test tube A, while acetic acid is added to test tube B. Amount and concentration taken for both the acids are same. In which test tube reaction occurs more vigourously and why?

FURTHER REFERENCE

Books:

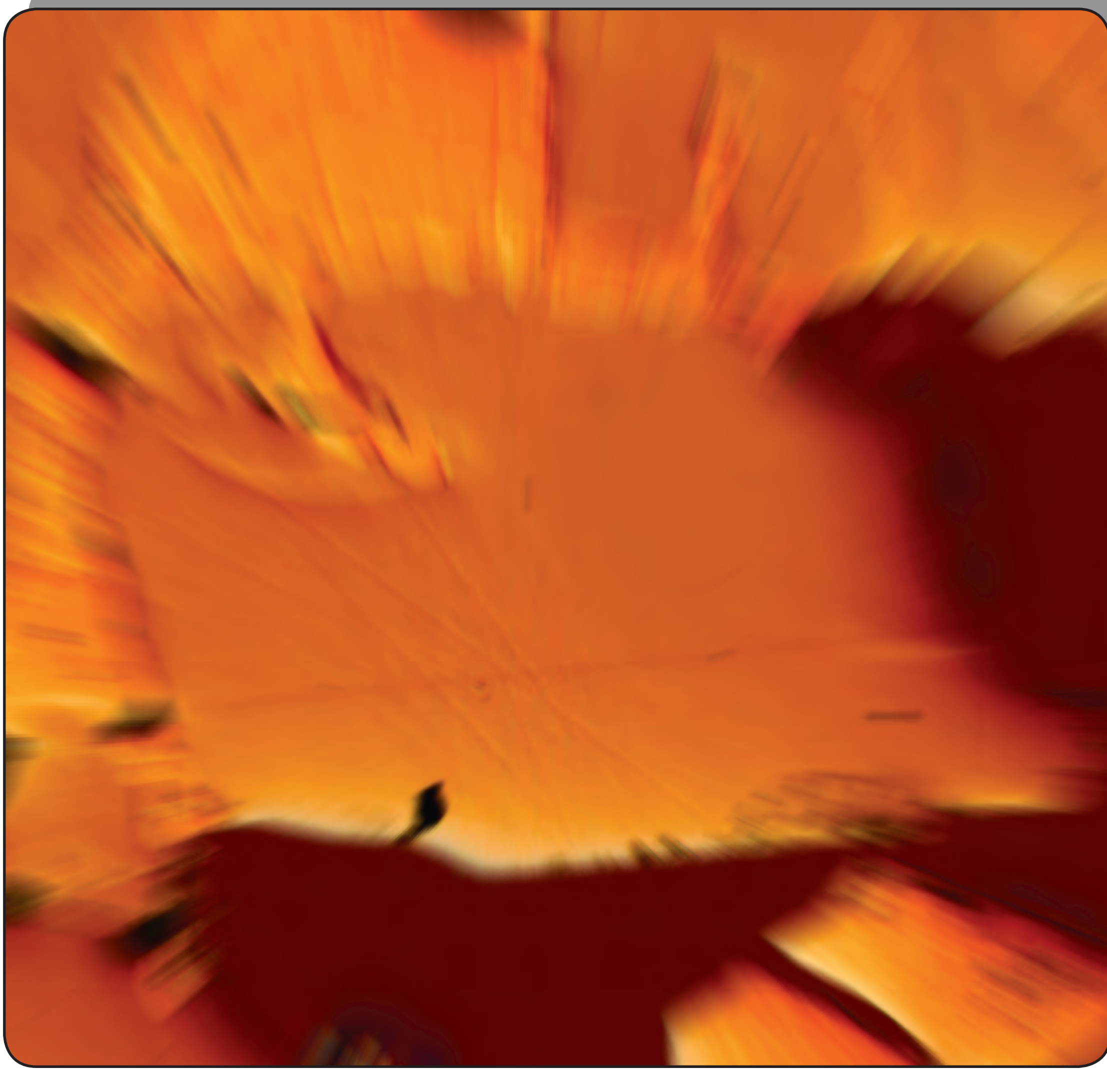
1. Text book of Inorganic Chemistry–**P.L. Soni - S.Chand & sons** publishers
2. Principles of Physical Chemistry –B.R. Puri, L.R. Sharma Vishal publishers

Websites:

www. ask.com

www.chem4kids.com

Chapter 12



PERIODIC CLASSIFICATION OF ELEMENTS

12. Periodic classification of elements

Have you ever visited a library? There are thousands of books in a large library. If you ask for a book in general it is very difficult to trace. Whereas if you ask for a particular book, the library staff can locate it very easily. How is it possible? In library the books are classified into various categories and sub categories. They are arranged on shelves accordingly. Therefore locating books become very easy.

As on date one hundred and eighteen elements are known. It is difficult to identify each and every element individually and to know its property and uses. Therefore they have been classified on the basis of their similarities in properties. One of the important instincts of mankind is to be systematic. Scientists felt the necessity to group elements of similar characteristics together so that if the properties of one of them are known, those of the others could be guessed and related.

Henry Gwyn-Jeffreys Moseley, an English physicist (1887–1915), used X-rays to determine the atomic numbers of the elements.

When a large number of elements were discovered, several attempts were being made to arrange them on the basis of their properties, nature, character, valency, etc., (Real credit for preparing the periodic table goes to Mendeleev).

12.1. MODERN PERIODIC LAW

A large number of scientists made attempts to eleminate the drawbacks of Mendeleev's periodic table. In 1912, Moseley, an English physicist measured the frequencies of X-rays emitted by a metal, when the metal was bombarded with high speed electrons. He plotted square roots of the frequencies against atomic numbers. The plot obtained was a straight line. He found that the square root of the frequency of the prominent X-rays emitted by a metal was proportional to the atomic number and not to the atomic weight of the atom of that metal.

MORE TO KNOW

Atomic number is number of protons in the nucleus or number of electrons revolving around the nucleus in an atom.

Moseley suggested that atomic number (Z) should be the basis of the classification of the element. Thus, he gave modern periodic law as follows:

Modern periodic law states that **"the physical and chemical properities of elements are the periodic function of their atomic numbers."**

Thus, according to the modern periodic law, if elements are arranged in the increasing order of their atomic numbers, the elements with similar properties are repeated after certain regular intervals.

12.2. MODERN PERIODIC TABLE

Based on the modern periodic law, a number of forms of periodic table have been proposed from time to time but general plan of the table remained the same as proposed by Mendeleev. The table which is most commonly used and which is based upon the **electronic configuration of elements** is called the **long form of the periodic table**. This is called the **modern periodic table.**

12.2.1. Description of modern or long form of the periodic table

Long form of the periodic table is a chart of elements in which the elements have been arranged in the increasing order of their atomic numbers. This table consists of **horizontal rows called periods and vertical columns called groups**.

MORE TO KNOW

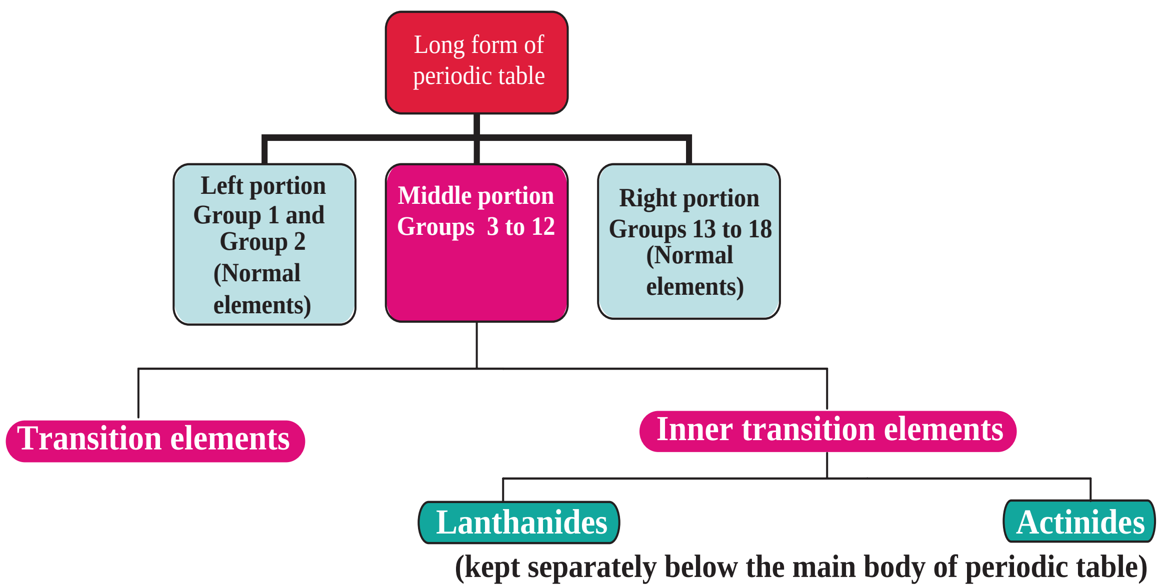
The modern periodic table has also been divided into four blocks known as s,p,d and f blocks.

12.2.3. Study of periods

The **horizontal rows are called periods**. There are **seven** horizontal rows in the periodic table.

- **First period** (Atomic number 1 and 2): This is the shortest period. It contains only two elements (hydrogen and helium).
- **Second period** (Atomic number 3 to 10): This is a short period. It contains eight elements (lithium to neon).
- **Third period** (Atomic number 11 to 18): This is also a short period. It contains eight elements (sodium to argon).

12.2.2. Different portions of long form of periodic table



- **Fourth period** (Atomic number 19 to 36): This is a long period. It contains eighteen elements (potassium to krypton). This includes 8 normal elements and 10 transition elements.
- **Fifth period** (Atomic number 37 to 54): This is also a long period. It contains 18 elements (rubidium to xenon). This includes 8 normal elements and 10 transition elements.
- **Sixth period** (Atomic number 55 to 86): This is the longest period. It contains 32 elements (ceasium to radon). This includes 8 normal elements, 10 transition elements and 14 inner transition elements (lanthanides).
- **Seventh period** (Atomic number 87 to 118): As like the sixth period, this period also can accomodate 32 elements. Till now only 26 elements have been authenticated by IUPAC.

12.2.4. Study of groups

- Vertical columns in the periodic table starting from top to bottom are called groups. There are 18 groups in the periodic table.
- First group elements are called alkali metals.
- Second group elements are called alkaline earth metals.
- Groups three to twelve are called transition elements .
- Group 1, 2 and 13 - 18 are called normal elements or main group elements or representative elements .
- Group 16 elements are called chalcogen family (except polonium).
- Group 17 elements are called halogen family.
- Group 18 elements are called noble gases or inert gases.
- The lanthanides and actinides which form part of the group 3 are called inner transition elements.

12.3. CHARACTERISTICS OF MODERN PERIODIC TABLE

12.3.1. Characteristics of Periods

- In a period, the electrons are filled in the same valence shell of all elements.
- As the electronic configuration changes along the period, the chemical properties of the elements also change.
- Atomic size of the elements in a period decreases from left to the right.
- In a period, the metallic character of the element decreases while their non-metallic character increases.

12.3.2. Characteristics of Groups

- The elements present in 2 and 18 groups differ in atomic number by 8,8,18,18,32.
- The elements present in 13 – 17 groups differ in atomic number by 8,18,18,32.
- The elements present in 4 - 12 groups differ in atomic number by 18,32,32.

MODERN PERIODIC TABLE

Key: Atomic Number, Symbol, Name, Atomic Mass (electrons per shell in brackets)

C Solid; Hg Liquid; H Gas; Rf Unknown

Metals: Alkali Metals; Alkaline earth metals; Lanthanoids; Actinoids; Transition metals; Poor metals

Nonmetals: Other nonmetals; Noble gases

Group Numbers

PERIODS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Shells
1	1 H Hydrogen 1.00794 (1)																	2 He Helium 4.002602 (2)	K
2	3 Li Lithium 6.941 (2 1)	4 Be Beryllium 9.012182 (2 2)											5 B Boron 10.811 (2 3)	6 C Carbon 12.0107 (2 4)	7 N Nitrogen 14.0067 (2 5)	8 O Oxygen 15.9994 (2 6)	9 F Fluorine 18.9984032 (2 7)	10 Ne Neon 20.1797 (2 8)	K L
3	11 Na Sodium 22.98976928 (2 8 1)	12 Mg Magnesium 24.3050 (2 8 2)											13 Al Aluminium 26.9815386 (2 8 3)	14 Si Silicon 28.0855 (2 8 4)	15 P Phosphorus 30.973762 (2 8 5)	16 S Sulfur 32.065 (2 8 6)	17 Cl Chlorine 35.453 (2 8 7)	18 Ar Argon 39.948 (2 8 8)	K L M
4	19 K Potassium 39.0983 (2 8 8 1)	20 Ca Calcium 40.078 (2 8 8 2)	21 Sc Scandium 44.955912 (2 8 9 2)	22 Ti Titanium 47.867 (2 8 10 2)	23 V Vanadium 50.9415 (2 8 11 2)	24 Cr Chromium 51.9961 (2 8 13 1)	25 Mn Manganese 54.938045 (2 8 13 2)	26 Fe Iron 55.845 (2 8 14 2)	27 Co Cobalt 58.933195 (2 8 15 2)	28 Ni Nickel 58.6934 (2 8 16 2)	29 Cu Copper 63.546 (2 8 18 1)	30 Zn Zinc 65.409 (2 8 18 2)	31 Ga Gallium 69.723 (2 8 18 3)	32 Ge Germanium 72.64 (2 8 18 4)	33 As Arsenic 74.92160 (2 8 18 5)	34 Se Selenium 78.96 (2 8 18 6)	35 Br Bromine 79.904 (2 8 18 7)	36 Kr Krypton 83.798 (2 8 18 8)	K L M N
5	37 Rb Rubidium 85.4678 (2 8 18 8 1)	38 Sr Strontium 87.62 (2 8 18 8 2)	39 Y Yttrium 88.90585 (2 8 18 9 2)	40 Zr Zirconium 91.224 (2 8 18 10 2)	41 Nb Niobium 92.90638 (2 8 18 12 1)	42 Mo Molybdenum 95.94 (2 8 18 13 1)	43 Tc Technetium (98) (2 8 18 14 1)	44 Ru Ruthenium 101.07 (2 8 18 15 1)	45 Rh Rhodium 102.90550 (2 8 18 16 1)	46 Pd Palladium 106.42 (2 8 18 18 0)	47 Ag Silver 107.8682 (2 8 18 18 1)	48 Cd Cadmium 112.411 (2 8 18 18 2)	49 In Indium 114.818 (2 8 18 18 3)	50 Sn Tin 118.710 (2 8 18 18 4)	51 Sb Antimony 121.760 (2 8 18 18 5)	52 Te Tellurium 127.60 (2 8 18 18 6)	53 I Iodine 126.90447 (2 8 18 18 7)	54 Xe Xenon 131.293 (2 8 18 18 8)	K L M N O
6	55 Cs Caesium 132.9054519 (2 8 18 18 8 1)	56 Ba Barium 137.327 (2 8 18 18 8 2)	57-71	72 Hf Hafnium 178.49 (2 8 18 32 10 2)	73 Ta Tantalum 180.94788 (2 8 18 32 11 2)	74 W Tungsten 183.84 (2 8 18 32 12 2)	75 Re Rhenium 186.207 (2 8 18 32 13 2)	76 Os Osmium 190.23 (2 8 18 32 14 2)	77 Ir Iridium 192.217 (2 8 18 32 15 2)	78 Pt Platinum 195.084 (2 8 18 32 17 1)	79 Au Gold 196.966589 (2 8 18 32 18 1)	80 Hg Mercury 200.59 (2 8 18 32 18 2)	81 Tl Thallium 204.3833 (2 8 18 32 18 3)	82 Pb Lead 207.2 (2 8 18 32 18 4)	83 Bi Bismuth 208.98040 (2 8 18 32 18 5)	84 Po Polonium (209) (2 8 18 32 18 6)	85 At Astatine (210) (2 8 18 32 18 7)	86 Rn Radon (222) (2 8 18 32 18 8)	K L M N O P
7	87 Fr Francium (223) (2 8 18 32 18 8 1)	88 Ra Radium (226) (2 8 18 32 18 8 2)	89-103	104 Rf Rutherfordium 178.49 (2 8 18 32 32 10 2)	105 Db Dubnium (262) (2 8 18 32 32 11 2)	106 Sg Seaborgium (266) (2 8 18 32 32 12 2)	107 Bh Bohrium (264) (2 8 18 32 32 13 2)	108 Hs Hassium (277) (2 8 18 32 32 14 2)	109 Mt Meitnerium (268) (2 8 18 32 32 15 2)	110 Ds Darmstadtium (281) (2 8 18 32 32 17 1)	111 Rg Roentgenium (272) (2 8 18 32 32 18 1)	112 Cn Copernicium (285) (2 8 18 32 32 18 2)	113 Uut Ununtrium (284) (2 8 18 32 32 18 3)	114 Uuq Ununquadium (289) (2 8 18 32 32 18 4)	115 Uup Ununpentium (288) (2 8 18 32 32 18 5)	116 Uuh Ununhexium (292) (2 8 18 32 32 18 6)	117 Uus Ununseptium (2 8 18 32 32 18 7)	118 Uuo Ununoctium (294) (2 8 18 32 32 18 8)	K L M N O P Q

57 La Lanthanum 138.90547 (2 8 18 18 9 2)	58 Ce Cerium 140.116 (2 8 18 19 9 2)	59 Pr Praseodymium 140.90765 (2 8 18 21 8 2)	60 Nd Neodymium 144.242 (2 8 18 22 8 2)	61 Pm Promethium (145) (2 8 18 23 8 2)	62 Sm Samarium 150.36 (2 8 18 24 8 2)	63 Eu Europium 151.964 (2 8 18 25 8 2)	64 Gd Gadolinium 157.25 (2 8 18 25 9 2)	65 Tb Terbium 158.92535 (2 8 18 27 8 2)	66 Dy Dysprosium 162.500 (2 8 18 28 8 2)	67 Ho Holmium 164.93032 (2 8 18 29 8 2)	68 Er Erbium 167.259 (2 8 18 30 8 2)	69 Tm Thulium 168.93421 (2 8 18 31 8 2)	70 Yb Ytterbium 173.04 (2 8 18 32 8 2)	71 Lu Lutetium 174.967 (2 8 18 32 9 2)
89 Ac Actinium (227) (2 8 18 32 18 9 2)	90 Th Thorium 232.03806 (2 8 18 32 18 10 2)	91 Pa Protactinium 231.03588 (2 8 18 32 20 9 2)	92 U Uranium 238.02891 (2 8 18 32 21 9 2)	93 Np Neptunium (237) (2 8 18 23 8 2)	94 Pu Plutonium (244) (2 8 18 32 24 8 2)	95 Am Americium (243) (2 8 18 32 25 8 2)	96 Cm Curium (247) (2 8 18 32 25 9 2)	97 Bk Berkelium (247) (2 8 18 32 27 8 2)	98 Cf Californium (251) (2 8 18 32 28 8 2)	99 Es Einsteinium (252) (2 8 18 32 29 8 2)	100 Fm Fermium (257) (2 8 18 32 30 8 2)	101 Md Mendelevium (258) (2 8 18 32 31 8 2)	102 No Nobelium (259) (2 8 18 32 32 8 2)	103 Lr Lawrencium (262) (2 8 18 32 32 9 2)

- The elements present in a group have the same number of electrons in the valence shell of their atoms.
- The elements present in a group have the same valency.
- The elements present in a group have identical chemical properties.
- The physical properties of the elements in group such as melting point, boiling point, density vary gradually.
- Atomic radii of the elements present in a group increases downwards.

12.3.3. Advantages of the Modern Periodic Table

- The table is based on a more fundamental property ie., atomic number.
- It correlates the position of the element with its electronic configuration more clearly.
- The completion of each period is more logical. In a period as the atomic number increases, the energy shells are gradually filled up until an inert gas configuration is reached.
- It is easy to remember and reproduce.
- Each group is an independent group and the idea of sub-groups has been discarded.
- One position for all isotopes of an element is justified, since the isotopes have the same atomic number.
- The position of eighth group (in Mendeleev's table) is also justified in this table. All transition elements have been brought in the middle as the properties of transition elements are intermediate between left portion and right portion elements of the periodic table.
- The table completely separates metals from non-metals. The non-metals are present in upper right corners of the periodic table.
- The positions of certain elements which were earlier misfit (inter-changed) in the Mendeleev's periodic table are now justified because it is based on atomic number of the elements.
- Justification has been offered for placing lanthanides and actinides at the bottom of the periodic table.

12.3.4. Defects in the Modern Periodic Table

- Position of hydrogen is not fixed till now.
- Position of lanthanides and actinides has not been given inside the main body of periodic table.
- It does not reflect the exact distribution of electrons of some of transition and inner transition elements.

MORE TO KNOW

The last element authenticated by IUPAC is Cn112 [Copernicium]. However, the number of elements discovered so far is 118.

12.4. METALLURGY

I (Al) am a light silvery white metal to build aircraft .So, I am great.

I (Fe) am a lustrous steel metal to make machineries and bridges.So, I am great.

I (Cu) am a reddish brown metal to make coins. So, I am great.

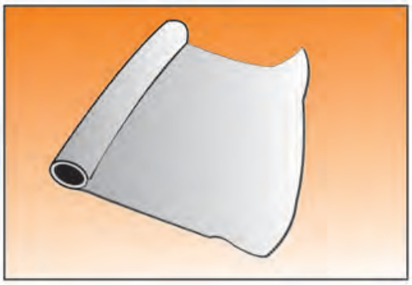
Individually you are great in your aspect.You will become the GREATEST IF YOU ARE ALLOYED TOGETHER.
Unity is strength.

INTRODUCTION

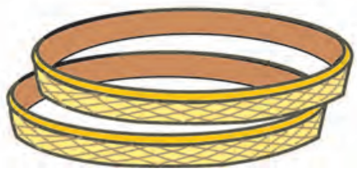
Metallurgy is as old as our civilization. Copper was the first metal to be used for making utensils, weapons and for other works. Metals play a significant role in our life. They constitute the mineral wealth of a country which is the measure of prosperity.

Metals like titanium, chromium, manganese, zirconium etc. find their applications in the manufacture of defence equipments. These are called **strategic metals**. The metal uranium plays, a vital role in nuclear reactions releasing enormous energy called nuclear energy. Copper, silver and gold are called **coinage metals** as they are used in making coins, jewellery etc.

Vietnameses Craft Work in silver



Aluminium foil



Bangles

MORE TO KNOW

Purity of gold is expressed in carat.

24 carat gold = pure gold.

For making ornaments 22 carat gold is used which contains 22 parts of gold by weight and 2 parts of copper by weight. The percentage of purity is $\frac{22}{24} \times 100 = 91.6\%$ (**916 Make gold**)

From one gram of gold, nearly 2km of wire can be drawn. Its an amazing fact indeed!

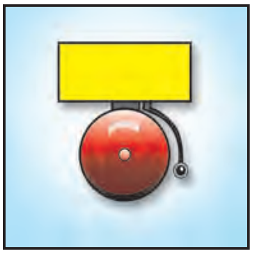
MORE TO KNOW

THE VITALITY OF METALS FOR THE TOTALITY OF LIFE

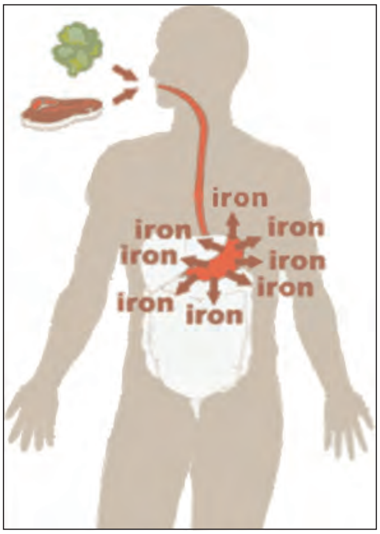
Metals in minute amounts are essential for various biological purposes. **Fe** – a constituent of blood pigment (haemoglobin).

Ca - a constituent of bone and teeth. **Co** - a constituent of vitamin B-12

Mg - constituent of chlorophyll.

METALS AROUND US



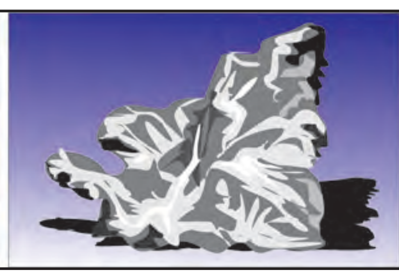
12.4. TERMINOLOGIES IN METALLURGY

12.4.1. Minerals: A mineral may be a single compound or complex mixture of various compounds of metals which are found in earth.

12.4.2. Ores: The mineral from which a metal can be readily and economically extracted on a large scale is said to be a ore.

For example, clay ($Al_2O_3.2SiO_2.2H_2O$) and bauxite ($Al_2O_3.2H_2O$) are the two minerals of aluminium. But aluminium can be profitably extracted only from bauxite. Hence **bauxite is an ore of aluminium and clay is its mineral**.


Gold


Silver


Aluminium

12.4.3. Differences between minerals and ores

- Minerals contain a low percentage of metal while ores contain a large percentage of metal.
- Metals cannot be extracted easily from mineral. On the other hand,ores can be used for the extraction of metals.
- All minerals cannot be called as ores,but all ores are minerals.

Mining: The process of extracting the ores from the earth crust is called mining.

Metallurgy: Various steps involved in the extraction of metals from their ores as well as refining of crude metal are collectively known as metallurgy.

Gangue or Matrix: The rocky impurity, associated with the ore is called gangue or matrix.

Flux: It is a compound added to the ore to remove its impurities by fusion.eg.CaO

Slag: It is the fusible product formed when flux reacts with gangue during the extraction of metals.

$$\text{Flux} + \text{Gangue} \rightarrow \text{Slag}$$

Smelting: Smelting is the process of reducing the roasted oxide to metals in the molten condition.

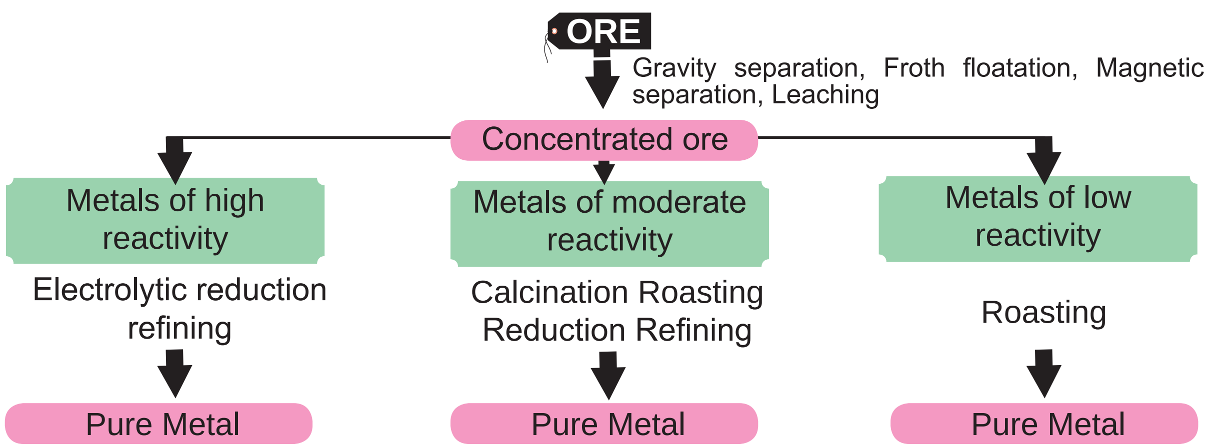
12.5. OCCURRENCE OF METALS

Nearly 80 metallic elements are obtained from mineral deposits on or beneath the surface of the earth.Metals which have low chemical reactivity are found in **free state, or in native state.**

Gold, silver and platinum are examples of metals that are partly found in a free state. Most of the other metals are found in a combined state in the form of their oxide ores, carbonate ores , halide ores, sulphide ores, sulphate ores and so on.

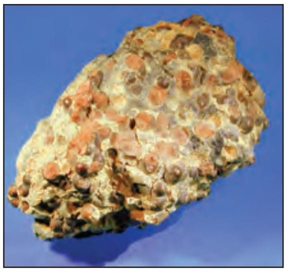
Oxide Ores	Carbonate Ores	Halide Ores	Sulphide Ores
Bauxite ($Al_2O_3.2H_2O$)	**Marble ($CaCO_3$)**	**Cryolite (Na_3AlF_6)**	**Galena (PbS)**
Cuprite (Cu_2O)	**Magnesite ($MgCO_3$)**	**Fluorspar (CaF_2)**	**Iron pyrite (FeS_2)**
Haematite (Fe_2O_3)	**Siderite ($FeCO_3$)**	**Rock salt (NaCl)**	**Zinc blende (ZnS)**

Flow Chart (Extraction of Metal from its ore)



12.6. METALLURGY OF ALUMINIUM, COPPER AND IRON

12.6.1. Metallurgy of aluminium



Symbol : Al
Colour : Silvery white
Atomic number : 13
Electronic configuration:2, 8, 3
Valency : 3
Atomic mass : 27

Position in the periodic table: period=3, group=13 (III A)

Aluminium is the most abundant metal in the earth's crust. Since it is a reactive metal it occurs in the combined state. The important ores of aluminium are as follows:

Name of the ore	Formula
Bauxite	$Al_2O_3.2H_2O$
Cryolite	Na_3AlF_6
Corundum	Al_2O_3

The chief ore of aluminium is bauxite ($Al_2O_3.2H_2O$).

Extraction of aluminium from bauxite involves two stages:1

1. Conversion of Bauxite into Alumina by Baeyer's Process

The conversion of Bauxite into Alumina involves the following steps:

i.Bauxite ore is finely grounded and heated under pressure with concentrated caustic soda solution at 150°C to obtain sodium meta aluminate.

$$\underset{\text{Bauxite}}{Al_2O_3.2H_2O} + 2NaOH \xrightarrow{150^\circ C} \underset{\text{Sodium Meta aluminate}}{2NaAlO_2} + 3H_2O$$

ii.On diluting sodium meta aluminate with water, aluminium hydroxide precipitate is obtained.

$$NaAlO_2 + 2H_2O \rightarrow NaOH + Al(OH)_3$$

iii.The precipitate is filtered, washed, dried and ignited at 1000°C to get alumina.

$$2Al(OH)_3 \xrightarrow{1000^\circ C} Al_2O_3 + 3H_2O$$

2.Electrolytic reduction of Alumina by Hall's process

Aluminium is produced by the electrolytic reduction of fused alumina (Al_2O_3) in the electrolytic cell.

Cathode : Iron tank lined with graphite

Anode : A bunch of graphite rods suspended in molten electrolyte

Electrolyte : Pure alumina + molten cryolite + fluorspar (fluorspar lowers the fusion temperature of electrolyte)

Temperature : 900-950°C

Voltage used : 5-6V

The overall equation for aluminium extraction is
$2Al_2O_3 \rightarrow 4Al + 3O_2$

Aluminium deposits at cathode and oxygen gas is liberated at anode

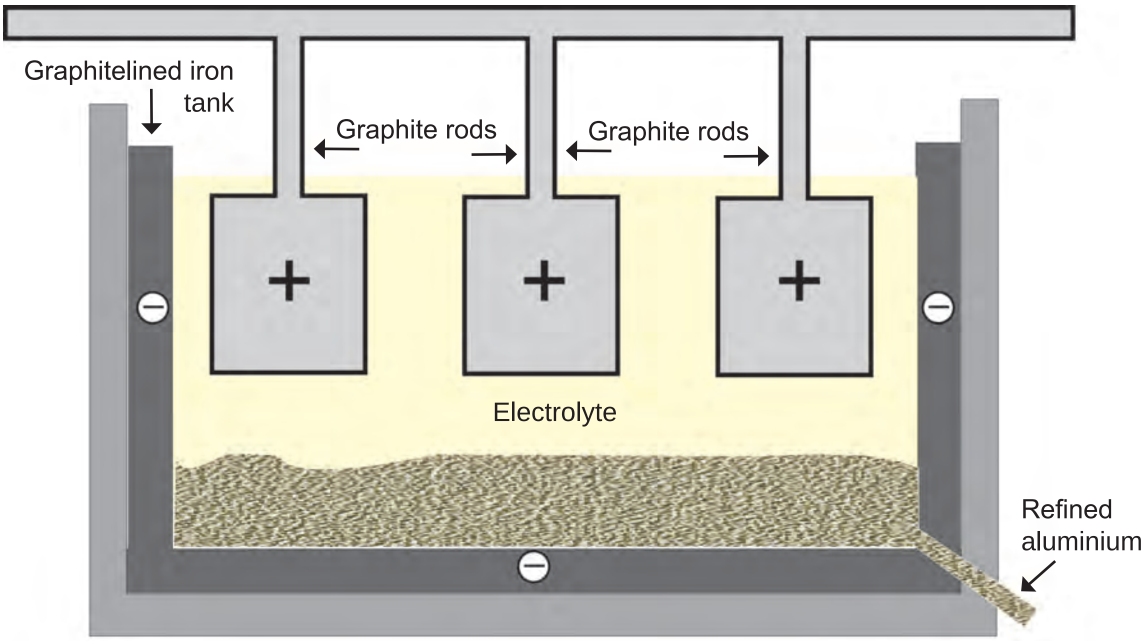


Fig 12.6.3 Electrolytic refining of aluminium

Properties of Aluminium

Physical properties:

i. It is a silvery white metal.
ii. It has low density and it is light
iii. It is malleable and ductile.
iv. It is a good conductor of heat and electricity.

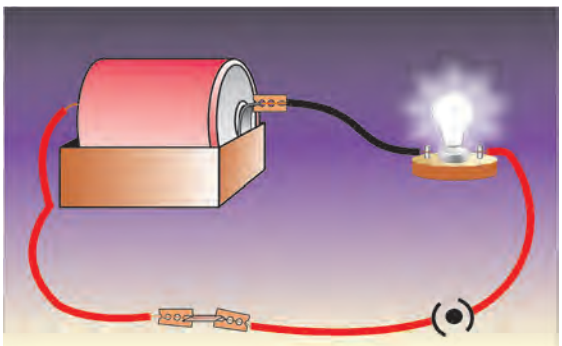


Fig. 12.6.4 Electric conductivity of metal

v. Melting point: 660°C
vi. It can be well polished to produce attractive shiny appearance.

Chemical properties:

1. Reaction with air: It is not affected by dry air. On heating at 800°C, aluminium burns very brightly forming its oxide and nitride.

$4Al + 3O_2 \rightarrow 2Al_2O_3$ (Aluminium Oxide)
$2Al + N_2 \rightarrow 2AlN$ (Aluminium Nitride)

2. Reaction with water: Water has no reaction on aluminium due to the layer of oxide on it. When steam is passed over red hot aluminium, hydrogen is produced.

$$2Al + \underset{\text{Steam}}{3H_2O} \rightarrow \underset{\text{Aluminium Oxide}}{Al_2O_3} + 3H_2\uparrow$$

3. Reaction with alkalis: It reacts with strong caustic alkalis forming aluminates.

$$2Al + 2NaOH + 2H_2O \rightarrow \underset{\text{Sodium meta aluminate}}{2NaAlO_2} + 3H_2\uparrow$$

4. Reaction with acids: With dilute and con. HCl it liberates H_2 gas.

$$2Al + 6HCl \rightarrow \underset{\text{Aluminium Chloride}}{2AlCl_3} + 3H_2\uparrow$$

Aluminium liberates hydrogen on reaction with dilute sulphuric acid. Sulphur dioxide is liberated with hot concentrated sulphuric acid.

$$2Al + 3H_2SO_4 \underset{\text{Dilute}}{} \rightarrow Al_2(SO_4)_3 + 3H_2\uparrow$$

Dilute

$$2Al + 6H_2SO_4 \rightarrow Al_2(SO_4)_3 + 6H_2O + 3SO_2\uparrow$$

hot & conc. Sulphuric acid — Aluminium Sulphate

MORE TO KNOW

MORE TO KNOW

Dilute or concentrated nitric acid does not attack aluminium. But it renders aluminium passive due to the formation of an oxide film on its surface.

5. Reducing action : Aluminium is a powerful reducing agent. When a mixture of aluminium powder and iron oxide is ignited, the latter is reduced to metal. This process is known as aluminothermic process.

$$Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$$

Uses of Aluminium

USES	FORM	REASON
1.Household utensils	Aluminium metal	It is light, cheap, corrosion resistant, and good conductor of heat.
2.Electrical cable industry	Aluminium wires	It is a good conductor of electricity.
3.Aeroplanes and other industrial parts	Duralumin (Al,Cu,Mg,Mn) Magnalium (Al,Mg)	Its alloys are light, have high tensile strength and are corrosion resistant.
4.Thermite welding	Al powder and Fe_2O_3	Its powder is a strong reducing agent and reduces Fe_2O_3 to iron.

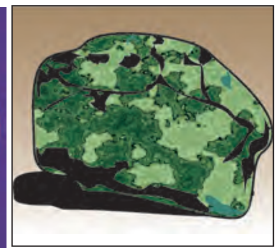
AirCraft - An alloy of aluminium

INDUSTRIAL VISIT

Fig 12.6.6

Make an industrial visit to the place where **Thermite welding** is actually done and record your observations on joining the gap between the broken pieces of rails.

12.6.2 Metallurgy of Copper



Symbol : Cu
Atomic mass : 63.55
Atomic number : 29
Electronic configuration : 2, 8, 18, 1
Valency : 1 and 2

Occurrence: It was named as cuprum by the Romans because they used to get it from the island of Cyprus. Copper is found in the **native state** as well as in the combined state.

Ores of copper	Formula
i. Copper pyrite	$CuFeS_2$
ii. Cuprite or ruby copper	Cu_2O
iii.Copper glance	Cu_2S

The chief ore of copper is copper pyrite. It yields nearly 76% of the world production of copper.

Extraction from copper pyrites:

Extraction of copper from copper pyrites involves the following steps.

1.**Crushing and concentration:** The ore is crushed and then concentrated by froth-floatation process.

2.**Roasting:** The concentrated ore is roasted in excess of air. During roasting,

i.moisture and volatile impurities are removed.
ii.copper pyrite is partly converted into sulphides of copper and iron.

$2CuFeS_2 + O_2 \rightarrow Cu_2S + 2FeS + SO_2$

3.**Smelting:** The roasted ore is mixed with powdered coke and sand and is heated in a blast furnace to obtain matte and slag. ***(Matte = Cu_2S + FeS)*** The slag is removed as a waste.

4.**Bessemerisation:** The molten matte is transferred to Bessemer converter in order to obtain ***blister copper.*** Ferrous sulphide from matte is oxidised to ferrous oxide which is removed as slag using silica.

$2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$
$2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$
$FeO+SiO_2 \rightarrow FeSiO_3$ (Iron silicate, slag)

5.**Refining:** Blister copper contains 98% pure copper and 2% impurities and are purified by electrolytic refining.

Electrolytic refining

This method is used to get metal of high degree of purity. For electrolytic refining of copper, we use

Cathode: A thin plate of pure copper metal.

Anode: A block of impure copper metal.

Electrolyte: Copper sulphate solution added with sulphuric acid. When electric current is passed through the electrolytic solution pure copper gets deposited at the cathode, impurities settled near the anode in the form of sludge called **anode mud**.

Properties

Physical properties: Copper is a reddish brown metal, with high lustre, high density and high melting point (1356^0C).

Chemical properties:

i.**Action of air and moisture:** Copper gets covered with a green layer of basic copper carbonate in the presence of CO_2 and moisture.

$2Cu + O_2 + CO_2 + H_2O \rightarrow CuCO_3.Cu(OH)_2$

ii. Action of Heat: On heating at different temperatures in the presence of oxygen it forms two types of oxides CuO, Cu_2O.

$2Cu + O_2 \xrightarrow{\text{below 1370K}} 2CuO$ (copper II oxide –black)

$4Cu + O_2 \xrightarrow{\text{above 1370K}} 2Cu_2O$ (copper I oxide-red)

iii. Action of Acids: a) with dil.HCl and dil.H_2SO_4

Dilute acids such as HCl and H_2SO_4 have no action on these metals in the absence of air. Copper dissolves in these acids in the presence of air.

$2Cu + 4HCl + O_2 \text{(air)} \rightarrow 2CuCl_2 + 2H_2O$
$2Cu + 2H_2SO_4 + O_2 \text{(air)} \rightarrow 2CuSO_4 + 2H_2O$

b) with dil.HNO_3 Copper reacts with dil. HNO_3 with the liberation of Nitric Oxide gas.

$3Cu + 8HNO_3\text{(dil)} \rightarrow 3Cu(NO_3)_2 + 2NO\uparrow + 4H_2O$

c) with con.HNO_3 and con.H_2SO_4

Copper reacts with con. HNO_3 and con. H_2SO_4 with the liberation of nitrogen dioxide and sulphur dioxide respectively.

$Cu + \underset{\text{(conc.)}}{4HNO_3} \rightarrow Cu(NO_3)_2 + 2NO_2\uparrow + 2H_2O$

$$Cu + \underset{(conc.)}{2H_2SO_4} \rightarrow CuSO_4 + SO_2\uparrow + 2H_2O$$

iv. Action of chlorine: Chlorine reacts with copper, resulting in the formation of copper (II) chloride.

$$Cu + Cl_2 \rightarrow CuCl_2$$

v. Action of alkalis: Copper is not attacked by alkalis.

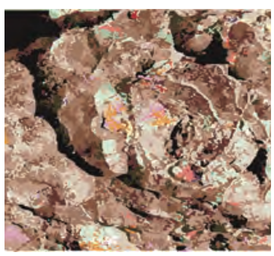
Uses

- It is extensively used for making electric cables and other electric appliances.
- It is used for making utensils, containers, calorimeters, coins.
- It is used in electroplating.
- It is alloyed with gold and silver for making coins and jewels.

PROJECT

Students may be asked to submit a project report on the important applications of copper in everyday life along with the samples.

12.6.3 METALLURGY OF IRON



Symbol	:	Fe
Colour	:	Greyish white
Atomic mass	:	55.9
Atomic number	:	26
Valency	:	2 & 3
Electronic configuration	:	2, 8, 14, 2

Occurrence:

Iron is the second most abundant metal after aluminium. It occurs in nature as oxides, sulphides and carbonates. The ores of iron are given in the following table:

Ores of iron	Formula
I. Haematite	Fe_2O_3
ii.Magnetite	Fe_3O_4
iii.Iron pyrites	FeS_2

Extraction of Iron from haematite ore (Fe_2O_3)

1.Concentration by gravity separation

The powdered ore is washed with stream of water. As a result, the lighter sand particles and other impurities are washed away and heavier ore particles settle down.

2.Roasting and calcination

The concentrated ore is strongly heated in a limited supply of air in a reverberatory furnace. As a result, moisture is driven out and sulphur, arsenic, phosphorus impurities are oxidised off.

3.Smelting (in Blast furnace)

The **charge** consisting of roasted ore, coke and limestone in the ratio **8 : 4 : 1** is smelted in a blast furnace by introducing it through the **cup and cone** arrangement at the top. There are three important regions in the furnance.

i.The lower region(combustion zone)-temperature is at 1500° C.

In this region, coke burns with oxygen to form CO_2 when the charge comes in contact with the hot blast of air.

$$C + O_2 \xrightarrow{1500°C} CO_2 + heat$$

It is an exothermic reaction since heat is liberated.

ii.The middle region (fusion zone)-The temperature prevails at 1000^{0}C.In this region CO_2 is reduced to CO.

$$CO_2 + C \xrightarrow{1000°C} 2CO$$

Limestone decomposes to calcium oxide and CO_2.

$$CaCO_3 \xrightarrow{\blacktriangle} CaO + CO_2$$

These two reactions are endothermic due to the absorption of heat. Calcium oxide combines with silica to form calcium silicate slag.

$$CaO + SiO_2 \rightarrow CaSiO_3$$

iii.The upper region (reduction zone)-temperature prevails at 400^{0}C. In this region carbon monoxide reduces ferric oxide to form a fairly pure spongy iron.

$$Fe_2O_3 + 3CO \xrightarrow{400°C} 3Fe + 3CO_2$$

The molten iron is collected at the bottom of the furnace after removing the slag.

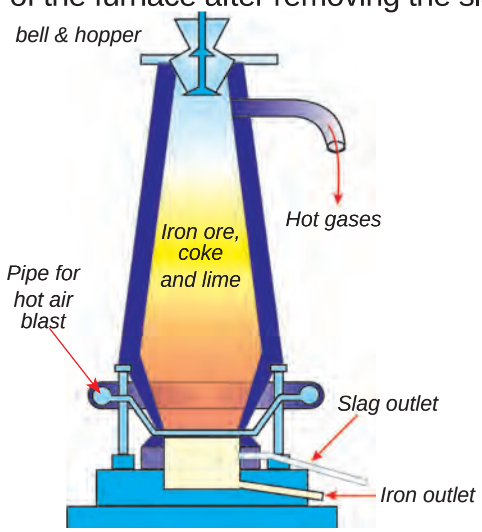


Fig. 12.8.3 Blast furnace

The iron thus formed is called **pig iron**. It is remelted and cast into different moulds. This iron is called **cast iron.**

MORE TO KNOW

CALCINATION AND ROASTING

CALCINATION: It is a process in which ore is heated in the absence of air. As a result of calcination the carbonate ore is converted into its oxide.

ROASTING: It is a process in which ore is heated in the **presence of excess of air**. As a result of roasting the sulphide ore is converted into its oxide.

MORE TO KNOW

Depending upon the carbon content iron is classified into 3 types.

Pig iron with carbon content of 2- 4.5%

Wrought iron with carbon content <0.25%

Steel with carbon content of 0.25-2%.

Physical properties

- It is a heavy metal of specific gravity 7.9
- It is a lustrous metal and greyish white in colour.
- It has high tensility, malleability and ductility.
- It is a good conductor of heat and electricity.
- It can be magnetised.

Chemical properties

1.Reaction with air or oxygen: Only on heating in air, iron forms magnetic oxide.

$3Fe + 2O_2 \rightarrow Fe_3O_4$ (black)

2.Reaction with moist air: When iron is exposed to moist air, it forms a layer of brown hydrated ferric oxide on its surface. This compound is known as rust and the phenomenon of forming this rust is known as rusting.

$4Fe + 3O_2 + \underset{\text{(Moisture)}}{3H_2O} \rightarrow 2Fe_2O_3.3H_2O$(Rust)

3.Reaction with steam: When steam is passed over red hot iron,magnetic oxide of iron is formed.

$3Fe + 4H_2O(steam) \rightarrow Fe_3O_4 + 4H_2\uparrow$

4.Reaction with chlorine: Iron combines with chlorine to form ferric chloride.

$2Fe + 3Cl_2 \rightarrow 2FeCl_3$(ferric chloride)

5.Reaction with acids: With dilute HCl and dilute H_2SO_4 it evolves H_2 gas.

$Fe + 2HCl \rightarrow FeCl_2 + H_2\uparrow$

$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2\uparrow$

With conc. H_2SO_4 it forms ferric sulphate

$2Fe + 6H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 3SO_2 + 6H_2O$

With dilute HNO_3 in cold condition it gives ferrous nitrate

$4Fe + 10HNO_3 \rightarrow 4Fe(NO_3)_2 + NH_4NO_3 + 3H_2O$

When iron is dipped in conc. HNO_3 it becomes chemically **inert or passive** due to the formation of a layer of iron oxide (Fe_3O_4) on its surface.

Uses of iron

i.**Pig iron** is used in making stoves, radiators, railings, man hole covers and drain pipes.

ii. **Steel** is used in the construction of buildings, machinery, transmission and T.V towers and in making alloys.

iii.**Wrought iron** is used in making springs, anchors and electromagnets.

12.7 ALLOYS

An alloy is a homogeneous mixture of two or more metals fused together.

Alloys are solid solutions. Alloys can be considered as solid solutions in which the metal with high concentration is **solvent** and the metal with low concentration is **solute**. For example, brass is an alloy of zinc(solute) in copper(solvent).

12.7.1 Methods of making alloys:

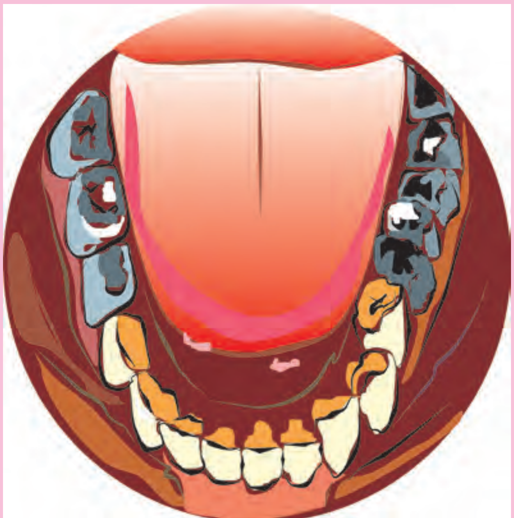
1.By fusing the metals together.
2.By compressing finely divided metals one over the other.

Amalgam: An amalgam is an alloy of mercury with metals such as sodium, gold, silver, etc.,

MORE TO KNOW

DENTAL AMALGAMS

It is an alloy of mercury with silver and tin metals. It is used in dental filling.



Dental amalgam

12.7.2 Copper Alloys

Name of the alloy	Reason for alloying	Uses
i.Brass(Cu,Zn) ii.Bronze(Cu,Sn,Zn)	Lusturous,easily cast,malleable, ductile,harder than Cu. Hard,brittle,takes up polish.	Electrical fittings, medals, hard ware, decorative items. Statues, coins, bells, gongs.

12.7.3 Aluminium Alloys

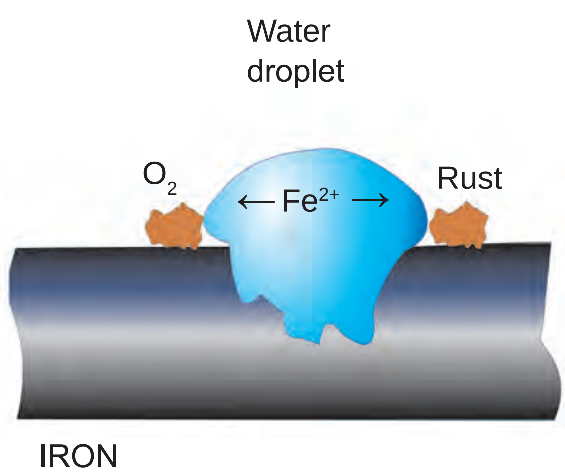
Name of the alloy	Reason for alloying	Uses
i.Duralumin(Al,Mg,Mn,Cu)	Light,strong,resistant to corrosion, stronger than aluminium.	Aircraft,tools,pressure cookers
ii.Magnalium(Al,Mg)	Light,hard,tough,corrosion resistant.	Aircraft,scientific instrument

12.7.4 Iron Alloys

Name of the alloy	Reason for alloying	Uses
i.Stainless steel (Fe,C,Ni,Cr)	Lusturous,corrosion resistant,high tensile strength.	Utensils,cutlery,automobile parts.
ii.Nickel steel (Fe,C,Ni)	Hard, corrosion resistant,elastic.	Cables,aircraft parts,propeller.

12.8 CORROSION

Corrosion is defined as the slow and steady destruction of a metal by the environment. It results in the deterioration of the metal to form metal compounds by means of chemical reactions with the environment.



Rusting of iron

MORE TO KNOW

MECHANISM OF CORROSION

Corrosion is a simple electro chemical reaction.

When the surface of iron is in contact with moisture and other gases in the atmosphere an electrochemical reaction occurs.In this, impure iron surface acts as the cathode and pure iron acts as anode. H_2CO_3 formed from moisture and CO_2 from air acts as electrolyte.

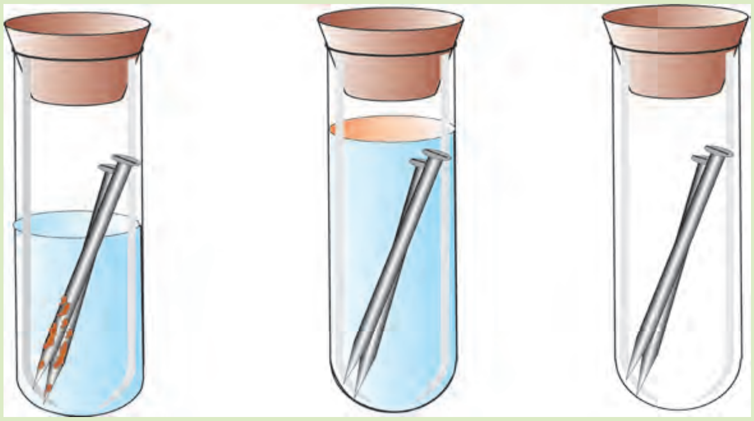
The electrochemical reactions are as follows:

$Fe \rightarrow Fe^{2+} + 2e^-$

$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$

The Fe^{2+} ions are oxidised to Fe^{3+} ions. The Fe^{3+} ions combine with OH^- ions to form $Fe(OH)_3$.This becomes **rust ($Fe_2O_3.xH_2O$) which is hydrated ferric oxide.**

ACTIVITY 9.1



The conditions for rusting

Take three test tubes provided with rubber corks and label them as A, B and C. Place few iron nails of same size in these tubes. Pour some water in test tube A, some boiled water along with turpentine oil in test tube B and anhydrous $CaCl_2$ in test tube C.Keep them under observation for few days. Notice the changes.

The nails in A are rusted while the nails in B and C are unaffected.

The rusting of nails in A is due to air and water. In B, the oily layer above water does not allow air to come in contact with nails. In C, the substance anhydrous $CaCl_2$ has absorbed moisture completely. This activity shows that rusting of iron requires air and water.

12.8.1 Methods of preventing corrosion

Corrosion of metals is prevented by not allowing them to come in contact with moisture,CO_2 and O_2.This is achieved by the following methods:

- **By coating with paints:** Paint coated metal surfaces keep out air and moisture.
- **By coating with oil and grease:** Application of oil and grease on the surface of iron tools prevents them from moisture and air.
- **By alloying with other metals:** Alloyed metal is more resistant to corrosion.
- **Example:** stainless steel.
- **By the process of galvanization:** This is a process of coating zinc on iron sheets by using electric current. In this zinc forms a protective layer of zinc carbonate on the surface of iron. This prevents corrosion.
- **Electroplating:** It is a method of coating one metal with another by passing electric current. Example: silver plating, nickel plating. This method not only lends protection but also enhances the metallic appearance.
- **Sacrificial protection:** Magnesium is more reactive than iron. When it is coated on the articles made of steel it sacrifices itself to protect the steel.

EVALUATION

PART A

1. In the modern periodic table periods and groups are given. Periods and groups indicate———
   a) Rows and Columns b) Columns and rows
2. Third period contains 8 elements, out of these elements how many elements are non-metals?.
3. An element which is an essential constituent of all organic compounds belongs to __________ group. (14th group / 15th group)
4. Ore is used for the extraction of metals profitably. Bauxite is used to extract aluminium, it can be termed as ________. (ore / mineral)
5. Gold does not occur in the combined form. It does not react with air (or) water. It is in ______. (native state / combined state)

PART B

6. Assertion: Greenish layer appears on copper vessels if left uncleaned.

   Reason: It is due to the formation of layer of basic copper carbonate

   Give your correct option.

a) assertion and reason are correct and relevant to each other

b) assertion is true but reason is not relevant to the assertion

7. A process employed for the concentration of sulphide ore is __________. (froth floation / gravity separation)
8. Coating the surface of iron with other metal prevents it from rusting. If it is coated with thin layer of zinc it is called __________ (galvanization / painting / cathodic protection)
9. Any metal mixed with mercury is called amalgam. The amalgam used for dental filling Is __________. (Ag – Sn amalgam / Cu – Sn amalgam)
10. Assertion In thermite welding, aluminium powder and Fe_2O_3 are used. Reason Aluminium powder is a strong reducing agent. Does the reason satisfy the assertion?

PART C

11. Can rusting of iron nail occur in distilled water. Justify your answer.
12. Why cannot aluminium metal be obtained by the reduction of aluminium oxide with coke?
13. Iron reacts with con. HCl and con. H_2SO_4. But it does not react with con. HNO_3. Suggest your answer with proper reason.
14. To design the body of the aircraft aluminium alloys are used. Give your reason.
15. X is a silvery white metal. X reacts with oxygen to form Y. The same compound is obtained from the metal on reaction with steam with the liberation of hydrogen gas. Identify X and Y.

FURTHER REFERENCE:

Books: Text Book of Inorganic chemistry – P.L. Soni S.Chand Publishers

Website: www.tutorvista.com. www.sciencebyjones.com

Chapter 13

CARBON AND ITS COMPOUNDS

13. Carbon and its compounds

Symbol	:	C
Atomic Number	:	6
Atomic Mass	:	12
Valency	:	4

The electronic configration of carbon is K=2, L=4. It has four electrons in the valence shell and belongs to group IV A (group 14) of the periodic table.

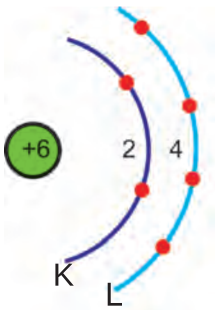


Fig. 13. 1 Electronic configuration of carbon

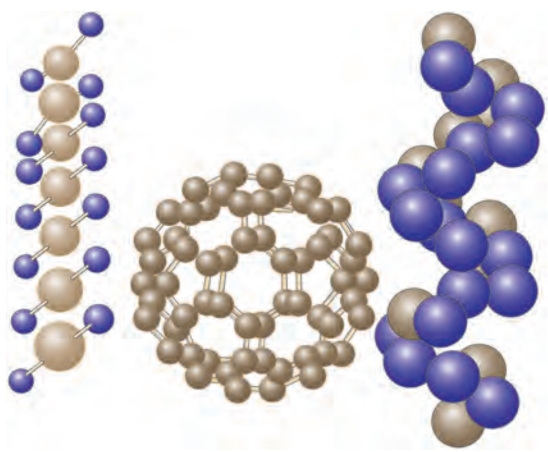


Fig. 13.2 Compounds of carbon in different arrangement

INTRODUCTION

Without carbon, no living thing could survive. Human beings are made of carbon compounds. Carbon is a non metal. In nature, it occurs in its pure form as **diamond and graphite.** When fuels burn, the carbon in them reacts with oxygen to form carbon dioxide.

Carbon compounds hold the key to plant and animal life on earth. Hence, carbon chemistry is called **Living Chemistry.** Carbon circulates through air, plants, animals and soil by means of complex reactions. This is called **carbon cycle**.

13.1. COMPOUNDS OF CARBON

In the beginning of 19th century scientists classified the compoundsof carbon into two types, based on their source of occurence:

i) Inorganic compounds (obtained from non living matter)

ii) Organic compounds (obtained from living matter, such as plant and animal sources) however the basis of classification was subjected to alteration after wohler synthesis.

LIVING CHEMISTRY

All living organisms are made of carbon atoms. This means that, carbon atoms form the building blocks for living organisms. These carbon atoms, in combination with other atoms decide life on earth. Hence **carbon chemistry** is also called as **living chemistry**.

Fig. 13.3

Fig. 13.4

FRIEDRICH WOHLER

A creater of revolution in **ORGANIC CHEMISTRY**

MORE TO KNOW

ORGANIC CHEMISTRY:

The word organic signifies life. The term organic chemistry was used by the Swedish chemist Berzelius. This refers to the chemistry of living things. However, the German chemist Wohler succeeded in creating an organic compound (urea) from an inorganic compound (ammonium cyanate) in his laboratory. This has dealt a severe blow to the vital force theory (a theory of life process).

FRIEDRICH WOHLER
A German Chemist

13.2. MODERN DEFINITION OF ORGANIC CHEMISTRY

Organic chemistry is defined as the branch of chemistry that deals with organic compounds which are made up of the hydrocarbons and their derivatives. It gives a thorough insight into the nature of bonding, synthesis, characteristics and their usefulness in various fields.

MORE TO KNOW

A polished diamond

The most precious diamond is a crystalline allotrope of carbon. KOHINOOR DIAMOND is a 105 carat diamond (21.68g) It was seized by the EAST INDIA COMPANY and became the part of British Crown Jewels. May it be an ordinary coal or the most precious Kohinoor diamond,it is an allotropic modification of carbon indeed!

13.3. BONDING IN CARBON AND ITS COMPOUNDS

The atomic number of carbon is 6 and its ground state electronic configuration is $1s^2\ 2s^2\ 2p^2$. Since it has four electrons in its outermost shell, its valency is four. To achieve noble gas configuration, carbon atom has to lose or gain four electrons to form C^{4+} and C^{4-} ions.

1. It could gain four electrons forming C^{4-} anion, but it would be difficult for the nucleus with six protons to hold on to ten electrons i.e.four extra electrons.
2. It could lose four electrons to form C^{4+} cations, but it would require a large amount of energy to remove four electrons leaving behind the carbon cations with six protons in its nucleus holding on to just two electrons.

Carbon overcomes this problem by sharing its valence electrons with other atoms of carbon or with atoms of other elements. *This characteristic of carbon atom by virtue of which it forms four covalent bonds is generally referred as* **tetra valency of carbon.**

A molecule of methane (CH_4) is formed when four electrons of carbon are shared with four hydrogen atoms.

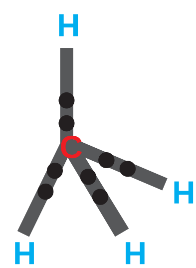


Fig. 13.3 Structure of methane

•• *Represents shared pair of electrons*

13.4 ALLOPROPY

Allotropy is defined as the property by which an element can exist in more than one form that are physically different but chemically similar.

Allotropes of carbon

- Carbon exists in three allotropic forms. They are crystalline form (diamond and graphite), amorphous form (coke,charcoal) and fullerene.
- In diamond each carbon atom is bonded to four other carbon atoms forming a rigid three dimensional structure, accounting for it's hardness and rigidity.

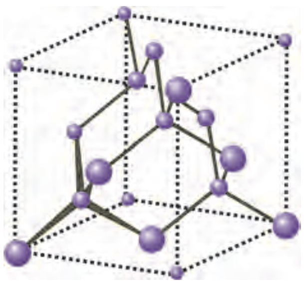


Fig. 13.4
Structure of diamond

- In graphite each carbon atom is bonded to three other carbon atoms in the same plane giving hexagonal layers held together by weak **vander Waals forces** accounting for softness.
- Graphite is a good conductor of electricity unlike other non-metals since it has free electrons in it.
- Fullerenes form another type of carbon allotropes. The first one was identified to contain 60 carbon atoms in the shape of a football. (C-60). Since this looks like the geodesic dome designed by the US architect Buck Minster Fuller, it is named as Buck Minster Fullerene.

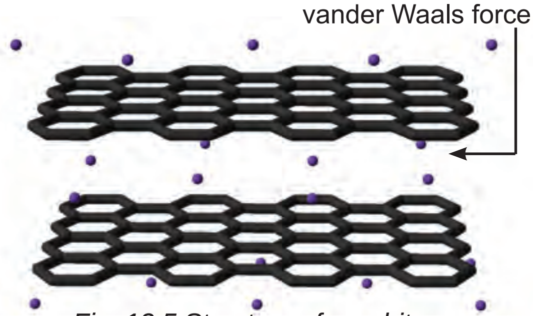


Fig. 13.5 Structure of graphite

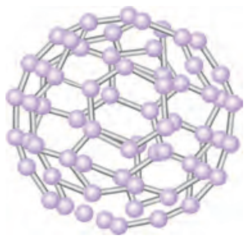


Fig. 13.6 Fullerene

Fig. 13.7 Foot ball

13.5 Physical nature of carbon and its compounds

- Carbon has the ability to form covalent bonds with other atoms of carbon giving rise to large number of molecules through self linking property. This property is called ***catenation***. Since the valency of carbon is four, it is capable of bonding with four other atoms of carbon.
- Carbon combines with oxygen, hydrogen, nitrogen, sulphur, chlorine and many other elements to form various stable compounds.
- The stability of carbon compounds is due to the small size of carbon which enables the nucleus to hold on to the shared pair of electrons strongly.
- Carbon compounds show ***isomerism***, the phenomenon by which two or more compounds to have same molecular formula but different structural formula with difference in properties. i.e the formula C_2H_6O represents two different compounds namely ethyl alcohol (C_2H_5OH) and dimethyl ether (CH_3OCH_3).
- Carbon compounds have low melting and boiling points because of their covalent nature.

- The reactions shown by carbon compounds involve breaking of old bonds in the reacting molecules and the formation of new bonds in the product molecules.
- Carbon compounds are easily combustible.

13.6 CHEMICAL PROPERTIES

- Carbon and its compounds burn in oxygen to give carbon dioxide along with heat and light.

e.g.,

$C + O_2 \rightarrow CO_2 + \text{heat} + \text{light}$

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \text{heat} + \text{light}$

$C_2H_5OH + 2O_2 \rightarrow 2CO_2 + 3H_2O + \text{heat} + \text{light}$

- Carbon compounds can be easily oxidized using suitable oxidizing agent (Alkaline potassium permanganate) to form carboxylic acids.
- Unsaturated carbon compounds undergo addition reactions with hydrogen in the presence of palladium or nickel catalyst.

e.g.,

$$\underset{\text{Ethene}}{CH_2 = CH_2} \xrightarrow[\text{Ni-catalyst}]{\text{Addition of hydrogen}} \underset{\text{Ethane}}{CH_3 - CH_3}$$

- Carbon compounds undergo substitution reactions in the presence of either sunlight or any other reagents. E.g methane undergoes substitution reaction to form different types of products.
- Carbon compounds such as alcohols react with sodium to liberate hydrogen gas.

e.g: $2CH_3CH_2OH + 2Na \rightarrow 2CH_3CH_2ONa + H_2$

13.7 HOMOLOGOUS SERIES

A homologous series is a group or a class of organic compounds having similar structure and similar chemical properties in which the successive compounds differ by a CH_2 group.

13.7.1 Characteristics of homologous series

- Each member of the series differs from the preceeding or succeeding member by a common difference of CH_2 and by a molecular mass of 14 amu (amu = atomic mass unit).
- All members of homologous series contain same elements and the same functional groups.
- All members of homologous series have same general molecular formula.

e.g **Alkane = C_nH_{2n+2}**

Alkene = C_nH_{2n}

Alkyne = C_nH_{2n-2}

- The members in homologous series show a regular gradation in their physical properties with respect to increase in molecular mass.
- The chemical properties of the members of the homologous series are similar.
- All members of homologous series can be prepared by using same general method.

13.8 IMPORTANCE OF HOMOLOGOUS SERIES

1. It helps to predict the properties of the members of the series that are yet to be prepared.
2. Knowledge of homologous series gives a systematic study of the members.
3. The nature of any member of the family can be ascertained if the properties of the first member are known.

13.9 HYDROCARBONS

The simplest organic compounds containing only carbon and hydrogen are called ***Hydrocarbons.*** These are regarded as the **parent organic compounds** and all other compounds are considered to be derived from them by the replacement of one or more hydrogen atoms by other atoms or groups of atoms.

Hydro carbons are classified into two types: *saturated and unsaturated hydrocarbon*s.

13.9.1 Saturated hydrocarbons – Alkanes

General formula = C_nH_{2n+2} Suffix : ane

These are the organic compounds which contain carbon – carbon single bond.These were earlier named as

paraffins(Latin : meaning little affinity) due to their least chemical reactivity. According to IUPAC system, these are named as ***alkanes*** (ane is suffix with root word).

Formula	Common name	IUPAC name
CH_4	Methane	Methane
CH_3CH_3	Ethane	Ethane
$CH_3CH_2CH_3$	Propane	Propane
$CH_3CH_2CH_2CH_3$	n-Butane	Butane

13.9.2 Unsaturated hydrocarbons

These are hydrocarbons which contain carbon to carbon double bonds $\left(-\overset{|}{C}=\overset{|}{C}-\right)$ or carbon to carbon triple bonds **-C≡C-** in their molecules.These are further classified into two types: ***alkenes and alkynes*.**

i)***Alkenes***: ***General formula:* C_nH_{2n} *Suffix:* ene**

The hydrocarbons containing atleast one carbon to carbon double bond are called ***alkenes.***They have the general formula C_nH_{2n} .These were previously called ***olefins*** (Greek : olefiant – oil forming) because the lower gaseous members of the family form oily products when treated with chlorine.

In IUPAC system, the name of alkene is derived by replacing suffix **ane** of the correspding alkane by **ene**.For example,

$CH_3 - CH_3$ ethane $H_2C = CH_2$ ethene

Fig. 13.8 Bromine Test

(Left) No change in colour - saturated, (Right) Decolouration occurs - unsaturated

In higher alkenes, the position of the double bond, can be indicated by assigning numbers 1, 2, 3, 4, ……to the carbon atoms present in the molecule.

Alkene	Common name	IUPAC name
$CH_2 = CH_2$	Ethylene	Ethene
$CH_3CH = CH_2$	Propylene	Propene
$CH_3CH_2–CH=CH_2$	α-Butylene	But–1–ene
$CH_3CH = CHCH_3$	β-Butylene	But–2–ene

ii) ***Alkynes***: ***General formula:*** C_nH_{2n-2} ***Suffix :*** **yne**

The hydrocarbons containing carbon to carbon triple bond are called ***alkynes***. Alkynes are named in the same way as alkenes i.e., by replacing suffix **ane** of alkane by **yne.** In higher members, the position of triple bond is indicated by giving numbers 1, 2, 3, 4, ….to the carbon atom in the molecule.

Alkyne	**Common name**	**IUPAC name**
$HC \equiv CH$	Acetylene	Ethyne
$H_3C – C \equiv CH$	Methyl acetylene	Propyne
$H_3C – C \equiv C – CH_3$	Dimethyl acetylene	But–2-yne
$H_3C - CH_2 –C \equiv CH$	Ethyl acetylene	But–1–yne

13.10. FUNCTIONAL GROUP

Functional group may be defined as an atom or group of atoms or reactive part which is responsible for the characteristic properties of the compounds. The chemical properties of organic compounds are determined by the functional groups while their physical properties are determined by the remaining part of the molecule.

Example: -OH => Alcohol | >C=O => Ketone

–CHO => Aldehyde | – COOH => Carboxylic acid

13.10.1. Classification of organic compounds based on functional group

1. Alcohols

Alcohols are carbon compounds containing **–OH** group attached to alkyl group. The general formula of alcohol is **R-OH** where '**R**' is an **alkyl group** and **–OH** is the **functional group**. The IUPAC name of alcohol is derived by replacing –**e**, in the word **alkane,** by the suffix –**ol**. Hence we get the name **alkanol**.

CHAPTER 13

Molecular formula	Common name	IUPAC name
CH_3OH	Methyl alcohol	Methanol
CH_3-CH_2-OH	Ethyl alcohol	Ethanol
CH_3- CH_2-CH_2-OH	n-Propyl alcohol	1-Propanol
CH_3-CH-CH_3 I OH	Isopropyl alcohol or secondary propyl alcohol	2-Propanol
CH_3- CH_2-CH_2-CH_2-OH	n-Butyl alcohol	1-Butanol
CH_3-CH-CH_2-OH I CH_3	Isobutyl alcohol	2-Methyl-1-propanol

2. Aldehydes

Aldehydes are carbon compounds containing **-CHO** group attached to alkyl group or hydrogen atom. The general formula of aldehydes is **R – CHO** where **'R'** is an **alkyl group** or **hydrogen atom** and – **CHO** is the **functional group**. The IUPAC name of aldehyde is derived by replacing –**e**, in the word alkane, by the suffix –**al**. Hence we get the name **"alkanal"**.

Molecular formula	Common name	IUPAC name
HCHO	Formaldehyde	Methanal
CH_3- CHO	Acetaldehyde	Ethanal
CH_3- CH_2- CHO	Propionaldehyde	Propanal
CH_3- CH_2-CH_2- CHO	Butyraldehyde	Butanal

3. Ketones

Ketones are carbon compounds containing carbonyl – **CO** – group attached to two alkyl groups. The general formula of ketone is **R-CO-R'** where **R** and **R'** are **alkyl groups** and – **CO** – is the **functional group**. The IUPAC name of ketone is derived by replacing –**e**, in the word alkane, by the suffix **-one.** Hence we get the name **"alkanone"**.

Molecular formula	Common name	IUPAC name
CH_3COCH_3	Dimethyl ketone (Acetone)	Propanone
$CH_3COCH_2CH_3$	Ethyl methyl ketone	Butanone
$CH_3CH_2COCH_2CH_3$	Diethyl ketone	3-Pentanone

4. Carboxylic Acids

Carboxylic acids are carbon compounds containing **–COOH** group attached to a hydrogen atom or alkyl group. The general formula of acid is **R-COOH** where **'R'** is a **hydrogen atom** or **alkyl group** and **–COOH** is the **functional group**. The IUPAC name of acid is derived by replacing – e, in the word alkane, by the suffix –oic acid. Hence we get the name **"alkanoic acid"**.

Molecular formula	Common name	IUPAC name
HCOOH	Formic acid	Methanoic acid
CH_3-COOH	Acetic acid	Ethanoic acid
CH_3- CH_2-COOH	Propionic acid	Propanoic acid
CH_3- CH_2-CH_2-COOH	n-Butyric acid	Butanoic acid

SOME IMPORTANT ORGANIC COMPOUNDS

Almost all the compounds are useful to us in a number of ways. Most of the fuels, medicines, paints, explosives, synthetic polymers, perfumes and detergents are basically organic compounds. In fact, organic chemistry has made our life colourful and also comfortable. Two commercially important compounds, ethanol and ethanoic acid are briefly discussed here.

13.11 ETHANOL (C_2H_5OH)

Ethanol or ethyl alcohol or simply alcohol is one of the most important members of the family of alcohols.

(1) Manufacture of ethanol from molasses

Molasses is a dark coloured syrupy liquid left after the crystallization of sugar from the concentrated sugar cane juice. Molasses still contain about 30% of sucrose which can not be separated by crystallization. It is converted into ethanol by the following steps:

(i) Dilution

Molasses is first diluted with water to bring down the concentration of sugar to about 8 to 10 percent.

(ii) Addition of ammonium salts

Molasses usually contains enough nitrogenous matter to act as food for yeast during fermentation. If the nitrogen content of the molasses is poor, it may be fortified by the addition of ammonium sulphate or ammonium phosphate.

(iii) Addition of yeast

The solution from step (ii) is collected in large 'fermentation tanks' and yeast is added to it. The mixture is kept at about 303K for a few days.During this period, the enzymes invertase and zymase present in yeast, bring about the conversion of sucrose into ethanol.

$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{\text{invertase}} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$

$$\underset{\text{Glucose or Fructose}}{C_6H_{12}O_6} \xrightarrow{\text{zymase}} \underset{\text{Ethanol}}{2C_2H_5OH} + 2CO_2\uparrow$$

The fermented liquid is technically called wash.

(iv) Distillation of wash

The fermented liquid containing 15 to 18 percent alcohol and the rest of the water, is now subjected to fractional distillation. The main fraction drawn, is an aqueous solution of ethanol which contains 95.5% of ethanol and 4.5% of water. This is called rectified spirit. This mixture is then heated under reflux over quicklime for about 5 to 6 hours and then allowed to stand for 12 hours. On distillation of this mixture, pure alcohol (100%) is obtained. This is called absolute alcohol.

MORE TO KNOW

FERMENTATION :

The slow chemical change taking place in an organic compound by the action of enzymes leading to the formation of smaller molecules is called fermentation.

2. Physical properties

(i) Ethanol is a clear liquid with burning taste.

(ii) Its boiling point is 351K which is higher than corresponding alkane.

(iii) It is completely miscible with water in all proportions.

3. Chemical properties

(i) Dehydration

(a) Intra molecular dehydration : Ethanol, when heated with excess conc. H_2SO_4 at 443 K undergoes intra molecular dehydration (i.e. removal of water within a molecule of ethanol).

$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[443K]{Conc.H_2SO_4} \underset{\text{Ethene}}{CH_2{=}CH_2} + H_2O$$

(b) Inter molecular dehydration: When excess of alcohol is heated with conc. H_2SO_4 at 413K two molecules condense by losing a molecule of water to form ether (i.e. removal of water from two molecules of ethanol).

$$C_2H_5\text{-}OH + HO\text{-}C_2H_5 \xrightarrow[413K]{Conc.H_2SO_4} \underset{\text{Diethyl ether}}{C_2H_5\text{-}O\text{-}C_2H_5} + H_2O$$

(ii) Reaction with sodium : Ethanol reacts with sodium metal to form sodium ethoxide and hydrogen gas.

$$2C_2H_5OH + 2Na \longrightarrow \underset{\text{sodium ethoxide}}{2C_2H_5ONa} + H_2\uparrow$$

(iii) Oxidation : Ethanol is oxidized to ethanoic acid with alkaline $KMnO_4$ or acidified $K_2Cr_2O_7$

$$CH_3CH_2OH \xrightarrow{Oxidation} \underset{\text{Ethanoic acid}}{CH_3COOH} + H_2O$$

During this reaction, orange colour of $K_2Cr_2O_7$ changes to green. Therefore, this reaction can be used for the **identification of alcohols**.

(iv) Esterificaiton : Ethanol reacts with ethanoic acid in the presence of conc.H_2SO_4 (catalyst) to form ethyl ethanoate and water. The compound formed by the reaction of an alcohol with carboxylic acid is known as ester (fruity smelling compound) and the reaction is called esterification.

$$\underset{\text{Ethanol}}{C_2H_5OH} + \underset{\text{Ethanoic acid}}{CH_3COOH} \xrightarrow{\text{conc.}H_2SO_4} \underset{\text{Ethyl ethanoate}}{CH_3COOC_2H_5} + H_2O$$

(v) Dehydrogenation : When the vapour of ethanol is passed over reduced copper catalyst at 573 K, it is dehydrogenated to acetaldehyde.

$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[573\text{ K}]{Cu} \underset{\text{Acetadehyde}}{CH_3CHO+H_2}$$

4. Uses

Ethanol is used

1. As an anti-freeze in automobile radiators.
2. As a preservative for biological specimen.
3. As an antiseptic to sterilize wounds in hospitals.
4. As a solvent for drugs, oils, fats, perfumes, dyes, etc.
5. In the preparation of methylated spirit (mixture of 95% of ethanol and 5% of methanol), rectified spirit (mixture of 95.5% of ethanol and 4.5% of water), power alcohol (mixture of petrol and ethanol) and denatured sprit (ethanol mixed with pyridine).
6. In cough and digestive syrups.

Evil effects of consuming alcohol

- If ethanol is consumed, it tends to slow down metabolism of our body and depresses the central nervous system.
- It causes mental depression and emotional disorder.
- It affects our health by causing ulcer, high blood pressure, cancer, brain and liver damage.
- Nearly 40% accidents are due to drunken drive.

- Unlike ethanol, intake of methanol in very small quantities can cause death.
- Methanol is oxidized to methanal (formaldehyde) in the liver and methanal reacts rapidly with the components of cells.
- Methanal causes the protoplasm to get coagulated, in the same way an egg is coagulated by cooking. Methanol also affects the optic nerve, causing blindness.

13.12. ETHANOIC ACID (CH_3COOH)

Ethanoic acid is most commonly known as acetic acid and belongs to a group of acids called carboxylic acids. Acetic acid is present in many fruits and sour taste of fruits is because of this acid.

1. Preparation of Ethanoic acid

Ethanol on oxidation in the presence of alkaline potassium permanganate or acidified potassium dichromate gives ethanoic acid.

$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow{\text{Oxidation}} \underset{\text{Ethanoic acid}}{CH_3COOH} + H_2O$$

2. Physical properties

(i) Ethanoic acid is a colourless liquid and has a sour taste.

(ii) It is miscible with water in all proportions.

(iii) Boiling point (391 K) is higher than corresponding alcohols, aldehydes and ketones.

(iv) On cooling, pure ethanoic acid is frozen to form ice like flakes. They look like glaciers, so it is called glacial acetic acid.

3. Chemical properties

(i) Ethanoic acid is a weak acid but it turns blue litmus to red.

(ii) Reaction with metal

Ethanoic acid reacts with metals like Na, K, Zn, etc to form metal ethanoate and hydrogen gas.

$$2CH_3COOH + Zn \longrightarrow (CH_3COO)_2Zn + H_2\uparrow$$

$$2CH_3COOH + 2Na \longrightarrow 2CH_3COONa + H_2\uparrow$$

(iii) Reaction with carbonates and bicarbonates.

Ethanoic acid reacts with carbonates and bicarbonates and produces brisk effervescence due to the evolution of carbon dioxide.

$$2CH_3COOH + Na_2CO_3 \longrightarrow 2CH_3COONa + CO_2\uparrow + H_2O$$

$$CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + CO_2\uparrow + H_2O$$

(iv) Reaction with base

Ethanoic acid reacts with sodium hydroxide to form sodium ethanoate and water.

$$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$$

(v) Decarboxylation (Removal of CO_2)

When sodium salt of ethanoic acid is heated with soda lime (Solid mixture of 3 parts of NaOH and 1 part of CaO) methane gas is formed.

$$CH_3COONa \xrightarrow{NaOH\ /\ CaO} CH_4\uparrow + Na_2CO_3$$

4. USES

Ethanoic acid is used

1. For making vinegar which is used as a preservative in food and fruit juices.
2. As a laboratory reagent.
3. For coagulating rubber from latex.
4. In the preparation of dyes, perfumes and medicine.

EVALUATION

PART A

1. Assertion: Chemical bonds in organic compounds are covalent in nature.
   Reason: Covalent bond is formed by the sharing of electrons in the bonding atoms.
   Does the reason satisfy the given assertion?

2. Assertion: Diamond is the hardest crystalline form of carbon
   Reason: Carbon atoms in diamond are tetrahedral in nature.
   Verify the suitability of reason to the given Assertion mentioned above.

3. Assertion: Due to catenation a large number of carbon compounds are formed.
Reason: Carbon compounds show the property of allotropy.
Is the reason holding good for the given Assertion.

4. Buckminster Fullerene is the allotropic form of (Nitrogen / Carbon / Sulphur)

5. Eventhough it is a non metal, graphite conducts electricity. It is due to the presence of …………………(free electrons / bonded electrons)

6. Formula of methane is CH_4 and its succeeding member ethane is expressed as C_2H_6. The common difference of succession between them is (CH_2 / C_2H_2)

7. IUPAC name of first member of alkyne is ………….. (ethene / ethyne)

8. Out of ketonic and aldehydic group which is the terminal functional group?

9. Acetic acid is heated with a solid 'X' kept in a test tube. A colourless and odourless gas (Y) is evolved. The gas turns lime water milky when passed through it. Identify X and Y.

10. Assertion: Denaturation of ethyl alcohol makes it unfit for drinking purposes.
Reason: Denaturation of ethyl alcohol is carried out by methyl alcohol.
Check whether the reason is correct for assertion.

PART B

11. Write down the possible isomers and give their IUPAC names using the formula C_4H_{10}.

12. Diamond is the hardest allotrope of Carbon. Give reason for its hardness.

13. An organic compound (A) is widely used as a preservatives in pickles and has a molecular formula $C_2H_4O_2$. This compound reacts with ethanol to form a sweet smelling compound (B).

    (i) Identify the compound A and B.

    (ii) Name the process and write corresponding chemical equation.

14. An organic compound (A) of molecular formula C_2H_6O on oxidation with alkaline $KMnO_4$ solution gives an acid (B) with the same number of carbon atoms. Compound A is used as an antiseptic to sterilize wounds in hospitals. Identify A and B. Write the chemical equation involved in the formation of B from A.

PART C

15. Fill in the blanks using suitable formula in the given table

No.	Alkane	Alkene	Alkyne
1.	$C_2 H_6$ ethane	……….ethene	$C_2 H_2$ ethyne
2.	…….Propane	$C_3 H_6$ Propene	……propyne
3.	$C_4 H_{10}$ Butane	……….Butene	…….Butyne

16. Homologous series predict the properties of the members of hydrocarbon. Justify this statement through its characteristics.

17. Write the common name and IUPAC name of the following.

a) CH_3CH_2CHO

b) CH_3COCH_3

C) $CH_3 - \underset{\underset{OH}{|}}{CH} - CH_3$

d) $CH_3 COOH$

e) HCHO

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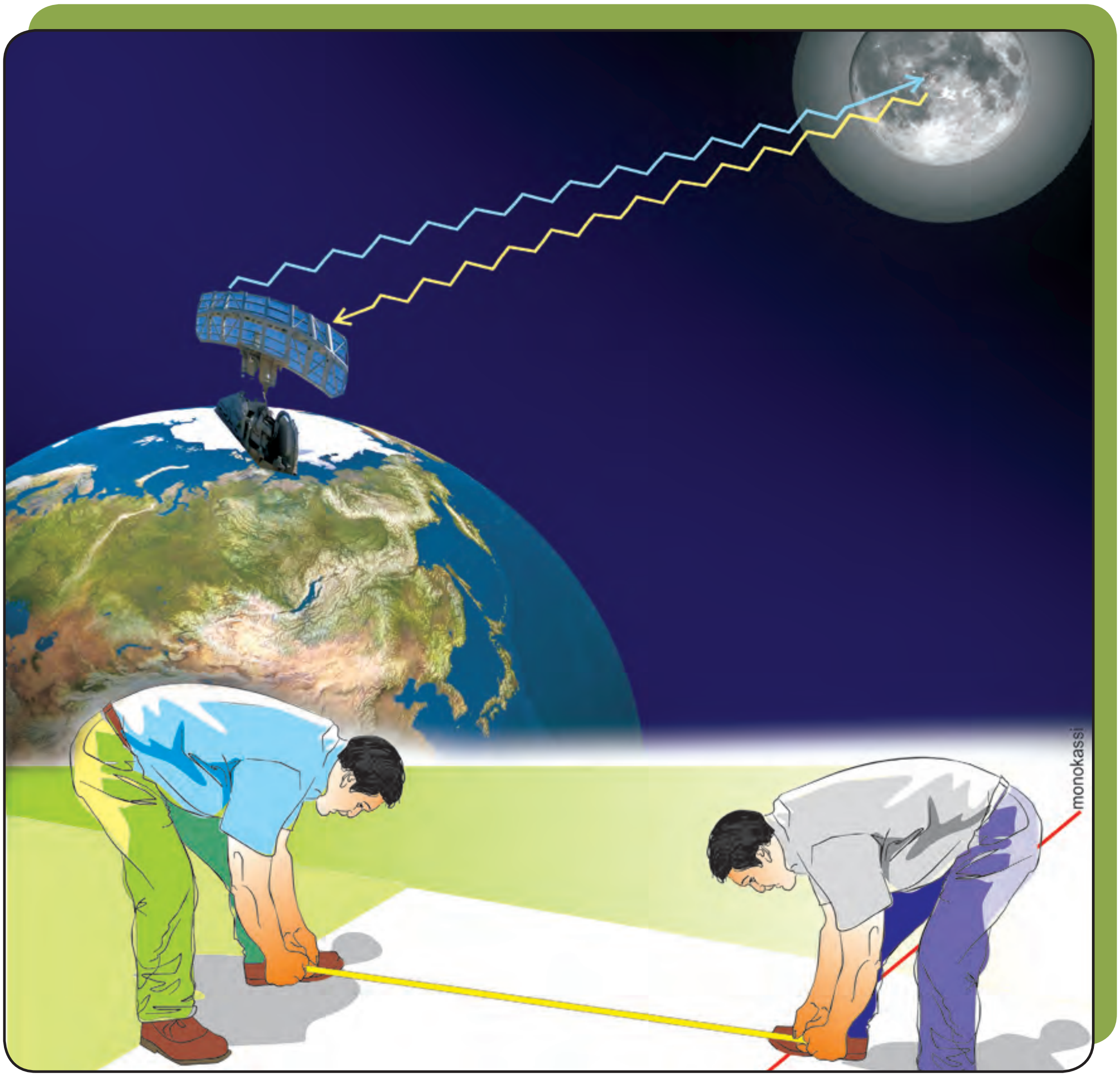
2.Organic chemistry - **R.T. Morrision & R.N. Boyd** - Practice Hall Publishers.

Website: www.tutorvista.com, www.topperlearning.com

Chapter 14



MEASURING INSTRUMENTS

14. Measuring Instruments

Physics is the most basic science, which deals with the study of nature and natural phenomena. It is a quantitative science. Therefore physicists measure things. The ultimate test of any physical quantity is its agreement with observations and measurement of physical phenomena. One of the major contributions of physics to other sciences and society are the many measuring instruments and techniques that physics has developed. One such instrument is screw gauge.

14.1 SCREW GAUGE

Screw Gauge is an instrument to measure the dimensions of very small objects upto 0.001 cm.

The Screw Gauge consists of 'U' shaped metal frame Fig. 14.1.

A hollow cylinder is attached to one end of the frame.

Grooves are cut on the inner surface of the cylinder through which a screw passes through.

On the cylinder parallel to the axis of the screw a scale is graduated in millimeter called Pitch Scale.

One end of the screw is attached to a sleeve.

The head of the sleeve is divided into 100 divisions called as the Head Scale.

The other end of the screw has a plane surface (s_1).

A stud (s_2) is attached to the other end of the frame, just opposite to the tip of the screw.

The screw head is provided with a ratchat arrangement (safety device) to prevent the user from exerting undue pressure.

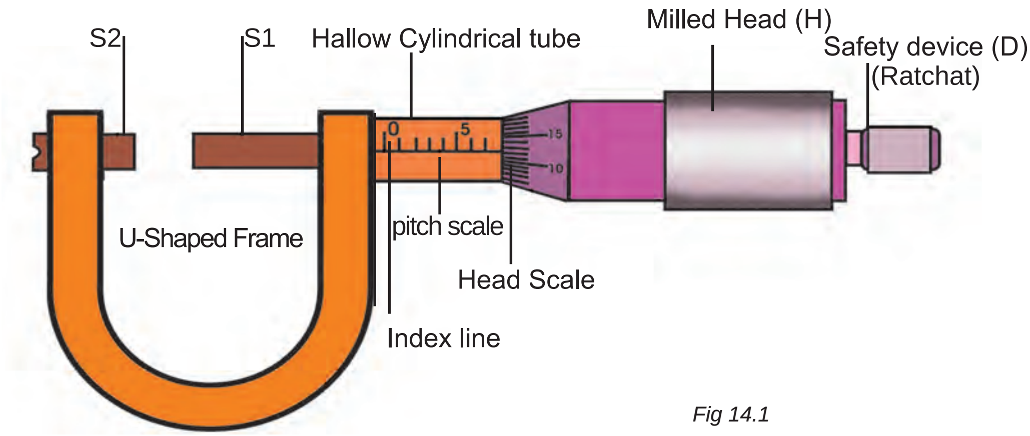


Fig 14.1

Principle of the Screw Gauge

Screw Gauge works under the principle of the screw. When a screw is rotated in a nut, the distance moved by the tip of the screw is directly proportional to the number of rotations.

Pitch of the screw

Pitch of the screw is the distance between two screw threads. It is also equal to the distance travelled by the tip of the screw for one complete rotation of the head.

$$\text{Pitch} = \frac{\text{Distance travelled on the pitch scale}}{\text{No.of rotations}}$$

Least Count of a Screw Gauge

The distance moved by the tip of the screw for a rotation of one division on the head scale is called the least count of the Screw Gauge.

$$\text{L.C} = \frac{\text{Pitch}}{\text{No.of divisions on the head scale}}$$

Zero Error of a Screw Gauge

The plane surface of the screw and the opposite plane stud on the frame are brought into contact. If the zero of the head scale coincides with the pitch scale axis, there is no zero error.Fig. 14.2

No Zero Error

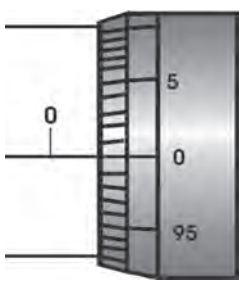


Fig. 14.2

Positive Zero Error

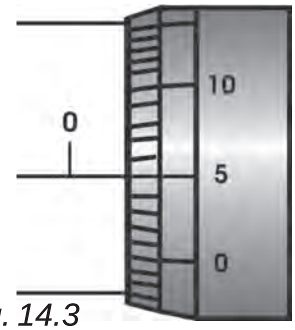


Fig. 14.3

If the zero of the head scale lies below the pitch scale axis, the zero error is positive. If the nth division of the head scale coincides with pitch scale axis the zero error is positive.Fig.14.3

Z.E = + (n x L.C) ,

Then the Zero Correction

Z.C = – (n x L.C)

Negative Zero Error

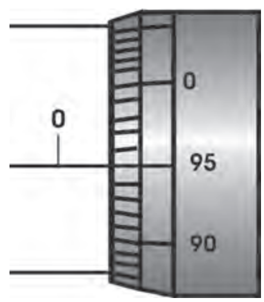


Fig 14.4

If the Zero of the head scale lies above the pitch scale axis, the zero error is negative. If the nth division coincides with the pitch scale axis, the zero error is negative.Fig. 14.4

Z.E = – (100 – n) x L.C,

Then the Zero Correction

Z.C = + (100 – n) x L.C

To measure the diameter of a thin wire using Screw Gauge

- Determine the Pitch, the Least count and the Zero Error of the Screw Gauge.
- Place the wire between two studs.
- Rotate the head until the wire is held firmly but not tightly, with the help of ratchat.
- Note the reading on the pitch scale crossed by the head scale (PSR) and the head scale reading coincides with the head scale axis (H.S.C).
- The diameter of the wire is given by P.S.R + (H.S.C x L.C) ± Z.C
- Repeat the experiment for different portions of the wire.
- Tabulate the readings.
- The average of the last column reading gives the diameter of the wire.

S.No	P.S.R mm	H.S.C	H.S.C x L.C mm	Total Reading P.S.R + (H.S.C x L.C) ±Z.C mm
1				
2				
3				

Nowadays we have digital Screw Gauge to take the reading at once.

14.2 Measuring long distances

For measuring long distances such as distance of the moon or a planet from the earth, special methods are adopted. Radio echo method, laser pulse method and parallax method are used to determine very long distances. In order to measure such very long distances the units astronomical distance and light year are used.

Astronomical distance

Astronomical distance is the mean distance of the centre of the sun from the centre of the earth.

1 Astronomical unit (AU) $= 1.496 \times 10^{11}$ m

Light year

Light year is the distance travelled by light in one year in vacuum.

Distance traveled by light in one year in vacuum = Velocity of light x I year (in seconds)

$= 3 \times 10^{8} \times 365.25 \times 24 \times 60 \times 60$

$= 9.467 \times 10^{15}$ m

Therefore , 1 light year $= 9.467 \times 10^{15}$ m

EVALUATION

PART A

1. Screw gauge is an instrument to measure the dimensions of very small objects upto__________

   (0.1 cm., 0.01 cm., 0.1 mm., 0.01 mm)

2. In a screw gauge zero of the head scale

lies below the pitch scale axis, the zero error is ________

(positive, negative, nil)

3. Screw gauge is used to measure the diameter of ________

(crow bar, thin wire, cricket ball)

4. One light year is equal to ________
(365.25 x 24 x 60 x 60 x 3 x 10^8 m ,
1 x 24 x 60 x 60 x 3 x 0^8 m ,
360 x 24 x 60 x 60 x 3 x 10^8 m)

5. One astronomical unit is the distace between the centre of the earth and ________

(centre of the Moon, centre of the Sun, centre of the Mars)

PART B

1. Correct the mistakes if any, in the following statements.

Astronomical distance is the mean distance of the surface of the sun from the surface of the earth.

Light year is the distance travelled by light in one year in vacuum at a speed of $3x10^8$ m. per minute

2. Match the items in group A with the items in group B

Group A	Group – B
Small dimensions	Kilo meter
Large dimensions	Screw gauge
Long distances	Scale
Small distances	Light year
	Altimeter

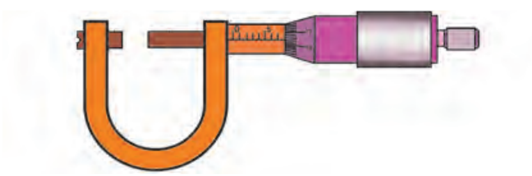
3. Fill in the blanks: Special methods adopted to determine very large distances are ________and ________ (Laser pulse method, Light year method, Radio echo method)

4. Least count of a screw gauge is an important concept related to screw gauge. What do you mean by the term least count of a screw gauge.

5. Label the following parts of the screw gauge in the given screw gauge diagram.

1. Head scale 2. Pitch scale

3. Axis 4. Ratchat



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2. Practical physics – Jerry. D. Wilson – Saunders college publishing

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www.physlink.com

Chapter 15

LAWS OF MOTION AND GRAVITATION

15. Laws of motion and gravitation

In our everyday life, we observe that some effort is required to put a stationary object into motion or to stop a moving object. Normally we have to push or pull or hit an object to change its state of motion.

The concept of force is based on this push, pull or hit. No one has seen, tasted, or felt force. However, we always see or feel the effect of a force. It can only be explained by describing what happens when a force is applied to an object. Push, pull or hit may bring objects into motion, because we make a force to act on them. Therefore, ***force is one which changes or tends to change the state of rest or of uniform motion of a body***. Force is a vector quantity. Its SI unit is ***newton.***

15.1. BALANCED AND IMBALANCED FORCES

Fig.15.1 shows a wooden block on a horizontal table. Two strings X and Y are tied to the two opposite faces of the block as shown.

If we apply a force by pulling the string 'X', the block begins to move to the right.

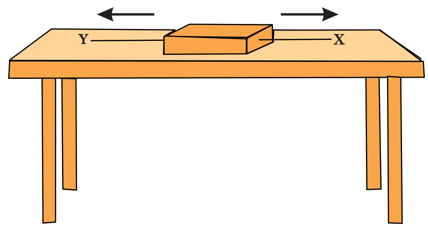
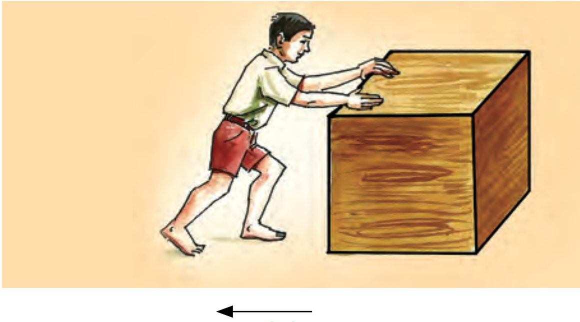


Fig. 15.1

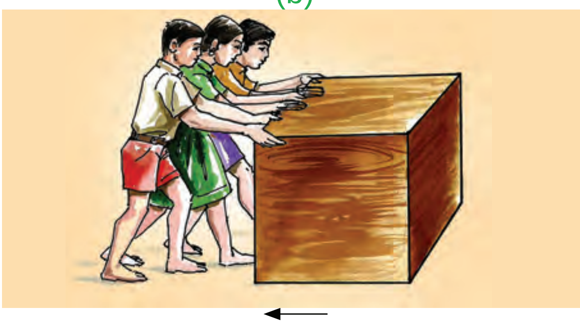
Similarly, if we pull the string Y, the block moves to the left. But, if the block is pulled from both the sides with equal forces the block will not move and remains stationary. Forces acting on an object which do not change the state of rest or of uniform motion of it are called ***balanced forces***. Now let us consider a situation in which two opposite forces of different magnitudes act on the block. The block moves in the direction of the greater force. The resultant of two forces acts on an object and brings it in motion. These opposite forces are called ***imbalanced forces***.

The following illustration clearly explains the concept of balanced and imbalanced forces. Some children are trying to push a box on a rough floor.



(a)

(b)



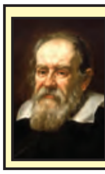
(c)

Fig. 15.2

If one boy pushes the box with a smaller force, the box does not move because of friction acting in a direction opposite to the push [Fig. 15.2(a)] This friction force arises between two surfaces in contact. In this case, between the bottom of the box and the floor rough surface. It balances the pushing force and therefore the box does not move. In [Fig.15.2(b)] two children push the box harder but the box still does not move. This is because the frictional force still balances the pushing force. If the children push the box harder still, the pushing force becomes bigger than the frictional force [Fig.15.2. (c)]. There is an imbalanced force. So, the box starts moving.

15.2 First law of motion

Galileo observed the motion of objects on an inclined plane. He deduced that objects move with a constant speed when no force acts on them.



Name	: Galileo
Born	:15 February 1564
Birth place	: Grand Duchy of Tuscany, Italy
Died	: 8 January 1642
Best known for	: Astronomy, physics and mathematics

Newton studied Galileo's ideas on force and motion and presented three fundamental laws that govern the motion of objects. These three laws are known as Newton's Laws of Motion. The first law of motion is stated as:

An object remains in the state of rest or of uniform motion in a straight line unless compelled to change that state by an applied unbalanced force. In other words, all objects resist a change in their state of motion. The tendency of undisturbed objects to stay at rest or to keep moving with the same velocity is called inertia. This is why, the first law of motion is also known as the law of inertia.

Certain experiences that we come across while travelling in a motor car can be explained on the basis of the law of inertia. We tend to remain at rest with respect to the seat until the driver applies a braking force to stop the motor car. With the application of brakes, the car slows down but our body tends to continue in the same state of motion because of inertia. A sudden application of brakes may thus cause injury to us by collision with panels in front.

An opposite experience is encountered when we are standing in a bus which begins to move suddenly. Now we tend to fall backwards. This is because a sudden start of the bus brings motion to the bus as well as to our feet in contact with the floor of the bus. But the rest of our body opposes this motion because of its inertia.

When a motor car makes a sharp turn at a high speed, we tend to get thrown to one side. This can again be explained on the basis of the law of inertia. We tend to continue in our straight line motion. When an unbalanced force is applied by the engine to change the direction of motion of the motor car, we move to one side of the seat due to the inertia of our body.

Inertia of a body can be illustrated through the following activities.

ACTIVITY 15.1

Make a pile of similar carrom coins on a table as shown in Fig.15.3.

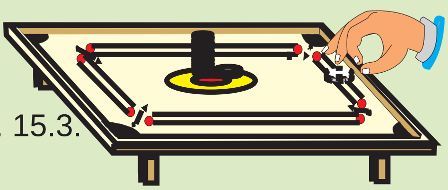


Fig. 15.3.

Attempt a sharp horizontal hit at the bottom of the pile using another carom coin or the striker. If the hit is strong enough, the bottom coin moves out quickly. Once the lowest coin is removed, the inertia of the other coins makes them 'fall' vertically on the table.

15.3. INERTIA AND MASS

All the examples and activities given so far, illustrate that there is a resistance offered by an object to change its state of motion. If it is at rest, it tends to remain at rest. If it is moving it tends to keep moving. This property of an object is called inertia. Therefore the ***inability of a body to change its state of rest or of uniform motion by itself is called inertia.***

Inertia of body depends mainly upon its mass. If we kick a foot ball, it flies away. But if we kick a stone of the same size with equal force, it hardly moves. We may, in fact get an injury in our foot. A force, that is just enough to cause a small carriage to pick up a large velocity, will produce a negligible change in the motion of a train. We say that train has more inertia than the carriage Clearly, more massive objects offer larger inertia. The inertia of an object is measured by its mass.

15.4 MOMENTUM

Let us recount some observations from our everyday life. During the game of table tennis, if a ball hits a player, it does not hurt him. On the other hand, when fast moving cricket ball hits a spectator, it may hurt him. A truck at rest does not require any attention when parked along a roadside. But a moving truck, even at a very low speed, may kill a person standing in its path. A small mass such as a bullet may kill a person when fired from a gun. These observations suggest that the impact produced by an object depends on its mass and velocity. In other words, there appears to exist some quantity of importance that combines the object's mass and velocity. One such property called momentum was introduced by Newton. ***The momentum 'p' of an object is defined as the product of its mass 'm' and velocity 'v'.*** That is, **$p=mv$**

Momentum has both direction and magnitude. It is a vector quantity. Its direction is same as that of the velocity. The SI unit of momentum is **kg ms^{-1}**.

15.5 SECOND LAW OF MOTION

Let us consider a situation in which a car with a dead battery is to be pushed along a straight road to give it a speed of 1 m s^{-1} which is sufficient to start its engine. If one or two persons give a sudden push (unbalanced force) to it, it hardly starts. But a continuous push over it sometime results in a gradual acceleration of the car to the required speed. It means that the change of momentum of the car is not only determined by the magnitude of the force, but also by the time during which the force is exerted. It may then also be concluded that the force necessary to change the momentum of the object depends on the time rate at which the momentum is changed.

The second law of motion states that the ***rate of change of momentum of an object is proportional to the applied unbalanced force in the direction of force***. Suppose an object of mass 'm' is moving along a straight line with an initial velocity 'u'. It is uniformly accelerated to velocity 'v' in time 't' by the application of constant force, 'F' throughout the time, 't'.

Initial momentum of the object = mu

Final momentum of the object = mv

The change in momentum = mv - mu = m(v - u) (1)

$$\text{Rate of change of momentum} = \frac{\text{Change of momentum}}{\text{time}}$$

$$= \frac{m(v-u)}{t} \quad (2)$$

According to Newton II law of motion, this is nothing but applied force.

$$\text{Therefore the applied force, } F = \frac{m(v-u)}{t}$$

$$\text{But the acceleration, } a = \frac{v-u}{t}$$

(which is the rate of change of velocity).

The applied force, $F \propto ma$

$$F = Kma \quad (3)$$

'K' is known as the constant of proportionality. The SI unit of mass and acceleration are kg and m s^{-2} respectively. The unit of force is so chosen that the value of the constant 'K' becomes one.

Therefore, **F = ma** (4)

1 unit of force = (1 kg) x (1 m s^{-2})

The unit of force is kg m s^{-2} or **newton** which has the symbol **'N'**.

One unit of force(1N) is defined as the amount of force that produces an acceleration of 1 m s^{-2} in an object of 1 kg mass.

The second law of motion gives us a method to measure the force acting on an object as a product of its mass and acceleration.

Example:15.1

A constant force acts on an object of mass 10 kg for a duration of 4 s. It increases the objects velocity from 2 ms^{-1} to 8 m s^{-1} Find the magnitude of the applied force.

Solution:

Given, mass of the object m = 10 kg

Initial velocity u = 2 m s^{-1}

Final velocity v = 8 m s^{-1}

We know, force $F = \dfrac{m(v - u)}{t}$

$$F = \frac{10\,(8-2)}{4} = \frac{10 \times 6}{4} = \mathbf{15\ N}$$

Example:15.2

Which would require a greater force for accelerating a 2 kg of mass at 4 m s^{-2} or a 3 kg mass at 2 m s^{-2}?

Solution

We know, force F = ma

Given, m_1 = 2 kg a_1 = 4 m s^{-2}

m_2 = 3 kg a_2 = 2 m s^{-2}

Thus, $F_1 = m_1 a_1 = 2\ \text{kg} \times 4\ \text{m s}^{-2} = \mathbf{8\ N}$

and $F_2 = m_2 a_2 = 3\ \text{kg} \times 2\ \text{m s}^{-2} = \mathbf{6\ N}$

$$\Rightarrow F_1 > F_2$$

Thus, accelerating a 2 kg mass at 4m s^{-2} would require a greater force.

15.6 THIRD LAW OF MOTION

Let us consider two spring balances connected together as shown in Fig. 15.4

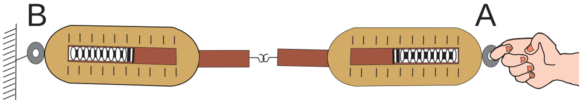


Fig. 15.4

The fixed end B of the balance is attached with a rigid support like a wall. When a force is applied through the free end of the spring balance A, it is observed that both the spring balances show the same readings on their scales. It means that the force exerted by spring balance A on balance B is equal but opposite in direction to the force exerted by the balance B on balance A. The force which balance A exerts on balance B is called action and the force of balance B on balance A is called the reaction.

Newton's third law of motion states that ***for every action there is an equal and opposite reaction.*** It must be remembered that the action and reaction always act on two different objects.

When a gun is fired it exerts forward force on the bullet. The bullet exerts an equal and opposite reaction force on the gun. This results in the recoil of the gun. Fig. 15.5

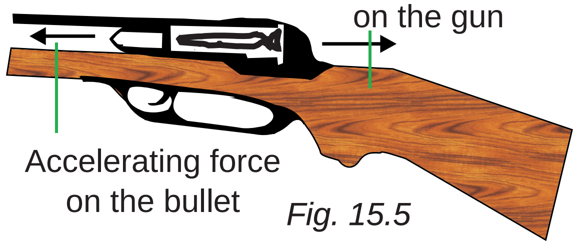


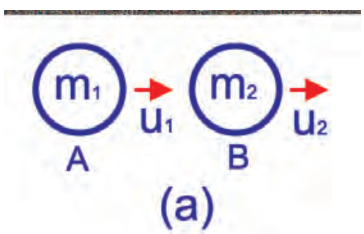
Fig. 15.5

Since the gun has a much greater mass than the bullet, the acceleration of the gun is much less than the acceleration of the bullet.

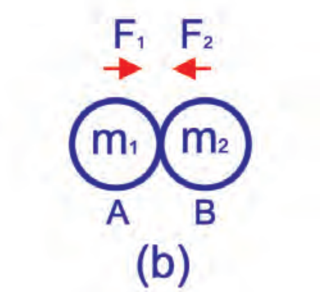
15.7 CONSERVATION OF MOMEN-TUM AND PROOF

The law of conservation of momentum states that, in the absence of external unbalanced force the total momentum of a system of objects remains unchanged or conserved by collision.

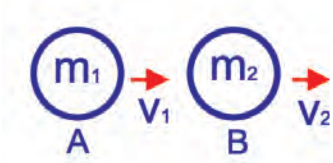
Consider two objects (two balls) A and B of masses 'm_1' and 'm_2' are traveling in the same direction along a straight line at different velocities 'u_1' and 'u_2' respectively Fig.15.6(a) .There are no other external unbalanced forces acting on them . Let $u_1 > u_2$ and the two balls collide with each other as shown in Fig. 15.6(b). During collision which last for time 't' , the ball A exerts a force F_1 on ball B , and the ball B exerts a force F_2 on ball A. Let v_1 and v_2 be the velocities of two balls A and B after collision respectively in the same direction as before collision, Fig 15.6(c).



Before collision



During collision



(C)

After collision

Fig. 15.6

According to Newton second law of motion

The force acting on B (action) F_1 = mass of B X acceleration on B.

$$F_1 = \frac{m_2 (v_2 - u_2)}{t} \qquad (1)$$

The force acting on A (reaction) F_2 = mass of A X acceleration on A.

$$F_2 = \frac{m_1 (v_1 - u_1)}{t} \qquad (2)$$

According to Newton's third law of motion

$$F_1 = -F_2$$

From equation (1) and (2)

$$\frac{m_2 (v_2 - u_2)}{t} = \frac{-m_1 (v_1 - u_1)}{t}$$

$$m_2 (v_2 - u_2) = -m_1 (v_1 - u_1)$$

$$m_2 v_2 - m_2 u_2 = -m_1 v_1 + m_1 u_1$$

$$m_1 v_1 + m_2 v_2 = m_1 u_1 + m_2 u_2$$

Therefore,

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

The ***total momentum before collision is equal to the total momentum after collision.*** The total momentum of two objects remain unchanged due to collision in the absence of external force. This law holds good for any number of objects.

ACTIVITY 15.2

Take a big rubber balloon and inflate it fully.Tie its neck using a thread.

ACTIVITY 15.2

Also using adhesive tape, fix a straw on the surface of this balloon.

- Pass a thread through the straw and hold one end of the thread in your hand or fix it on the wall.
- Ask your friend to hold the other end of the thread or fix it on a wall at some distance. This arrangement is shown in Fig.15.7
- Now remove the thread tied on the neck of the balloon. Let the air escape from the mouth of the balloon.
- Observe the direction in which the straw moves.

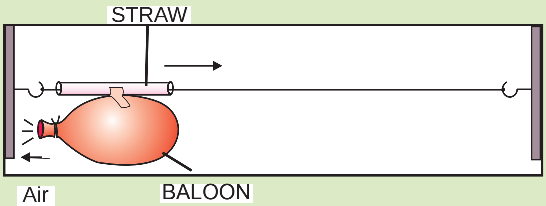


Fig. 15.7

Example:15.3

A bullet of mass 15g is horizontally fired with a velocity 100 m s^{-1} from a pistol of mass 2 kg what is the recoil velocity of the pistol?

Solution:

The mass of bullet, m_1 = 15 g = 0.015 kg

Mass of the pistol, m_2 = 2 kg

Initial velocity of the bullet, $u_1 = 0$

Initial velocity of the pistol, $u_2 = 0$

Final velocity of the bullet, v_1 = + 100 m s^{-1}

(The direction of bullet is taken from left to right-positive, by convention)

Recoil velocity of the pistol, = v

Total momentum of the pistol and bullet before fire,

$$= (0.015 \times 0 + 2 \times 0) \text{ kg m s}^{-1}$$

$$= 0 \text{ kg m s}^{-1}$$

Total momentum of the pistol and bullet after fire,

$$= (0.015 \times 100 + 2 \times v)$$

$$= (1.5 + 2v) \text{ kg m s}^{-1}$$

According to the law of conservation of momentum,

Total momentum after fire = total momentum before fire

$$1.5 + 2v = 0$$

$$2v = -1.5$$

$$v = -0.75 \text{ m s}^{-1}$$

Negative sign indicates that the direction in which the pistol would recoil is opposite to that of the bullet, that is, right to left.

15.8 MOMENT OF FORCE AND COUPLE

Moment of a force

A force can rotate a nut when applied by a wrench or it can open a door while the door rotates on its hinges. In addition to the tendency to move a body in the direction of the application of a force, a force also tends to rotate the body about any axis which does not intersect the line of action of the force and also not parallel to it. This tendency of rotation is called turning effect of a force or moment of the force about the given axis. ***The magnitude of the moment of force F about a point is defined as the product of the magnitude of force and***

the perpendicular distance of the point from the line of action of the force.

Let us consider a force F acting at the point P on the body as shown in Fig. 15.8

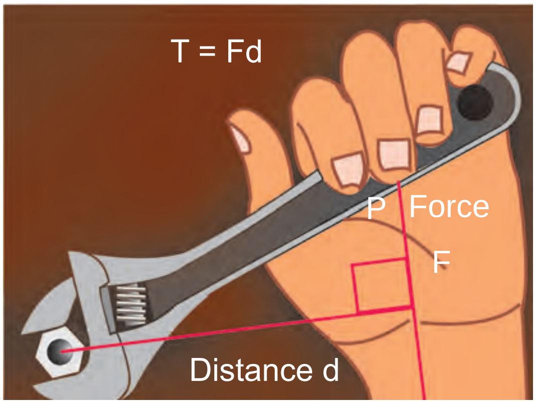


Fig. 15.8

Then, ***the moment of the force F about the point O = Magnitude of the force X perpendicular distance*** between the direction of the force and the point about which moment is to be determined = F x d.

If the force acting on a body rotates the body in anticlockwise direction with respect to O then the moment is called anticlockwise moment. On the other hand, if the force rotates the body in clockwise direction then the moment is said to be clockwise moment. The unit of moment of the force is **N m.**

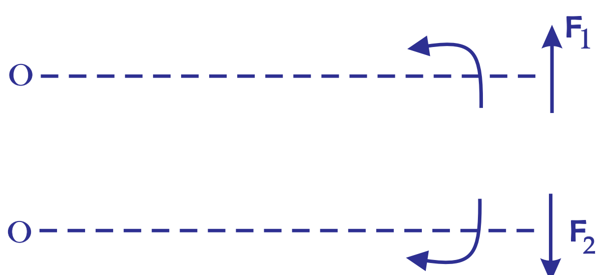


Fig. 15.9.

As a matter of convention, an anticlockwise moment is taken as positive and a clockwise moment as negative.

Couple

There are many examples in practice where two forces, acting together, exert a moment or turning effect on some object. As a very simple case, suppose two strings are tied to a wheel at the points X and Y, and two equal and opposite forces, 'F' are exerted tangentially to the wheels (Fig. 15.10). If the wheel is pivoted at its centre O it begins to rotate about O in an anticlockwise direction.

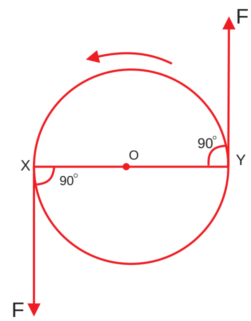


Fig. 1 5.10

Two equal and opposite forces whose lines of action do not coincide are said to ***constitute a couple in mechanics.***

15.9. GRAVITATION

Name	:	Isaac Newton
Born	:	4 January 1643
Birth Place	:	Woolsthrope, England
Died	:	20 March 1727
Best Known as	:	The genius who explained gravity.

We always observe that an object dropped from a height falls towards the earth. It is said that Newton was sitting under the tree, an apple fell on him. The fall of the apple made Newton start thinking. It is seen that a falling apple is attracted towards the

earth. Does the apple attract the earth? If so we do not see earth moving towards an apple. Why?

According to Newton's Third Law of Motion, the apple does attract the earth. But according to Second Law of motion, for a given force, acceleration is inversely proportional to the mass of the object. The mass of an apple is negligibly small compared to that of the earth. So we do not see the earth moving towards the apple. We know that all planets go around the sun. Extend the above argument for all planets in our solar system. There exist a force between sun and the planets. ***Newton concluded that all objects in the universe attract each other. This force of attraction between objects is called the gravitational force.***

ACTIVITY 15.3

Take a piece of thread. Tie a small stone at one end.

Hold the other end of the thread and whirl it round as shown in *Fig. 15.11.*

Note the motion of the stone.

Release the thread.

Again note the direction of motion of the stone.

Fig 15.11.

It is noted that the stone describes a circular path with a velocity of constant magnitude.

15.9.1. Newton law of gravitation

Every object in the universe attracts every other object with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. The force acts along the line joining the centers of two objects.

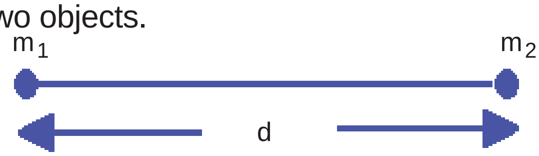


Fig. 15.12

Let two objects A and B of masses m_1, m_2 respectively lie at a distance 'd' from each other as shown in Fig.15.12. Let the force of attraction between two objects is 'F'. According to above law,

$$F \propto m_1 m_2 \quad (1)$$

$$F \propto \frac{1}{d^2} \quad (2)$$

Combining (1) and (2)

$$F \propto \frac{m_1 m_2}{d^2} \quad (3)$$

or $$F = \frac{G m_1 m_2}{d^2} \quad (4)$$

Where G is the constant of proportionality and is called the Universal gravitation constant. From eqn (4)

$$G = \frac{F.d^2}{m_1 m_2}$$

Substituting the S.I units in this equation the unit of G is found to be N $m^2 kg^{-2}$

The value of G is 6.673×10^{-11} N $m^2 kg^{-2}$

15.9.2 Mass

Mass is the amount of matter present in a body (or) is a measure of how much matter an object has.

15.9.3 Weight

Weight is the force which a given mass feels due to the gravity at its place (or) is a measure of how strongly gravity pulls on that matter.

If you were to travel to the moon, your weight would change because the pull of the gravity is weaker there than on the earth, but your mass would stay the same because you are still made up of the same amount of matter.

Example 15.4

Mass of an object is 5 kg. What is its weight on the earth?

Solution:

Mass, m = 5 kg
Acceleration due to gravity, g = 9.8 m s^{-2}

Weight, w = m × g

$$w = 5\ kg \times 9.8\ m\ s^{-2} = 49\ N$$

Thus the weight of the object is, **49 N**

Difference between mass and weight

Mass	Weight
1. Fundamental quantity.	Derived quantity.
2. It is the amount of matter contained in a body.	It is the gravitational pull acting on the body.
3. Its unit is kilogram.	It is measured in newton.
4. Remains the same.	Varies from place to place.
5. It is measured using physical balance.	It is measured using spring balance.

15.9.4 Acceleration due to gravity

Galileo was the first to make a systematic study of the motion of a body under the gravity of the Earth. He dropped various objects from leaning tower of Pisa and made analysis of their motion under gravity. He came to the conclusion that "***in the absence of air, all bodies will fall at the same rate".*** It is the air resistance that slows down a piece of paper or a parachute falling under gravity. If a heavy stone and a parachute are dropped where there is no air, both will fall together at the same rate.

Experiments showed that the velocity of a freely falling body under gravity increases at a constant rate. (i.e.) with a constant acceleration. ***The acceleration produced in a body on account of the force of gravity is called acceleration due to gravity***. It is denoted by **g**. At a given place, the value of **g** is the same for all bodies irrespective of their masses. It differs from place to place on the surface of the Earth. It also varies with altitude and depth.

The value of **g** at sea-level and at a latitude of 45° is taken as the standard free -fall acceleration (i.e.) **g=9.8 m s^{-2}**

PHYSICS

Acceleration due to gravity at the surface of the earth

Consider a body of mass 'm' on the surface of the earth as shown in Fig. 15.13.

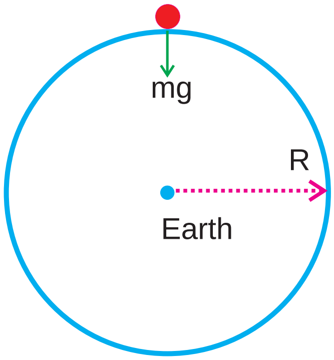


Fig.15.13

Its distance from the centre of the Earth is R (radius of the Earth).

The gravitational force experienced by the body is $F = \frac{GMm}{R^2}$ where M is the mass of the earth. From Newton's second law of motion,

$$\text{Force, } F = mg$$

Equating the above two forces,

$$F = \frac{GMm}{R^2} = mg$$

Therefore,
$$g = \frac{GM}{R^2}$$

This equation shows that 'g' is independent of the mass of the body 'm' but, it varies with the distance from the centre of the Earth. If the Earth is assumed to be a sphere of radius R, the value of 'g' on the surface of the Earth is given by

$$g = \frac{GM}{R^2}$$

15.9.5. Mass of earth

From the expression $g = GM/R^2$, the mass of the Earth can be calculated as follows:

$$M = \frac{gR^2}{G}$$

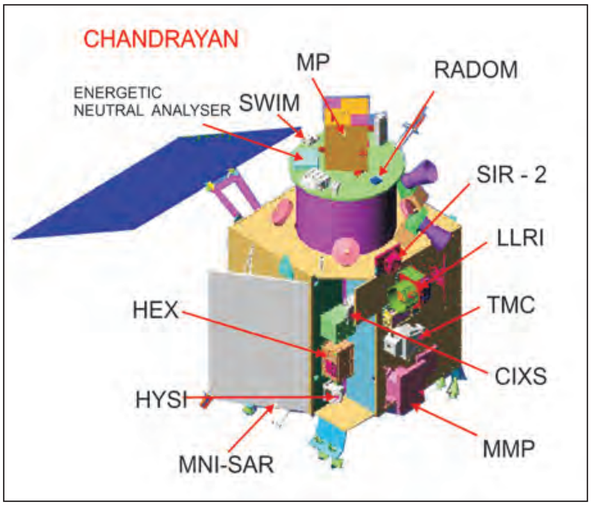
$M = 9.8 \times (6.38 \times 10^6)^2 / 6.67 \times 10^{-11}$
$M = 5.98 \times 10^{24}$ kg.

Science today

Chandrayaan

Mylswamy Annadurai born on 2^{nd} July 1958 is a household name in this part of the country .People fondly associate his name with chandrayaan to the extent it has almost become his middle name. He obtained his M.E Degree in Electronics in 1982. In the same year he joined in ISRO.

Annadurai is a leading technologist in the field of satellite system. Currently Annadurai serves as the Project Director of Chandrayaan-1 and Chandrayaan-2. He has made significant contribution to the cost effective design of Chandrayaan. Through his inspiring speeches he has become a motivating force among the Indian students.



Chandrayaan-1 is a moon-traveler or moon vehicle. It was Indian's first unmanned lunar probe. It was launched by Indian Space Research Organization in October 2008 from Srihari Kota in Andrapradesh and operated until August 2009. The mission included a lunar orbiter and an impactor. It carried five ISRO payloads and six payloads from other space agencies including NASA, European Space Agencies(ESA), and the Bulgarian Aerospace Agency which were carried free of cost.

Chandrayaan operated for 312 days and achieved 95% of its planned objectives. The following are its achievements,

- The discovery of wide spread presence of water molecules in lunar soil.
- Chandrayaan's Moon Mineralogy Mapper has confirmed that moon was once completely molten.
- European Space Agency payload-Chandrayaan-1 imaging X-ray spectrometer (CXIS)-detected more than two dozen weak solar flares during the mission.
- The terrain mapping camera on board Chandrayaan-1 has recorded images of the landing site of US space craft Apollo-15, Apollo-11.
- It has provided high-resolution spectral data on the mineralogy of the moon.
- Lunar Laser Ranging Instrument (LLRI) covered both the Lunar Poles and additional lunar region of interest.
- The X-ray signatures of aluminum, magnesium and silicon were picked up by the CXIS X-ray camera
- The Bulgarian payload called Radiation Dose Monitor (RADOM) was activated on the day of launch itself and worked till the mission end.
- More than 40000 images have been transmitted by Chandrayaan Camera in 75 days.
- The Terrain Mapping Camera acquired images of peaks and Craters. The moon consists of mostly of Craters.
- Chandrayaan beamed back its first images of the Earth in its entirety.
- Chandrayaan-1 has discovered large caves on the lunar surface that can act as human shelter on the moon.

Cryogenic techniques

The word cryogenics terms from Greek and means "the production of freezing cold".

In physics cryogenics is the study of the production of very low temperature (below 123K); and the behaviour of materials at those temperature. A person who studies elements under extremely cold temperature is called a cryogencist. Cryogenics use the Kelvin scale of temperature. Liquefied gases such as liquid nitrogen, liquid helium is used in many cryogenic applications.

PHYSICS

Liquid nitrogen is the most commonly used element in cryogenics and is legally purchasable around the world. Liquid helium is also commonly used and allows for the lowest attainable temperature to be reached. These liquids are held in special containers called Dewar flasks which are generally about six feet tall and three feet in diameter.

The field of cryogenics advanced during world war-2. Scientist found that metals frozen to low temperature showed more resistance to wear. This is known as cryogenic hardening. The commercial cryogenic processing industry was founded in 1966 by Ed Busch; and merged several small companies later to form oldest commercial cryogenic company in the world. They originally experimented with the possibility of increasing the life of metal tools.

Cryogens like liquid nitrogen are further used for specially chilling and freezing applications.

(i) Rocket

The important use of cryogenics is cryogenic fuels. Cryogenic fuels mainly liquid hydrogen has been used as rocket fuel.

(ii) Magnetic Resonance Imaging (MRI)

MRI is used to scan inner organs of human body by penetrating very intense magnetic field. The magnetic field is generated by super conducting coils with the help of liquid helium. It can reduce the temperature of the coil to around 4k. At this low temperature very high resolution images can be obtained.

(iii) Power transmission in big cities:

It is difficult to transmit power by over head cables in cities. So underground cables are used. But underground cables get heated and the resistance of the wire increases leading to wastage of power. This can be solved by cryogenics. Liquefied gases are sprayed on the cables to keep them cool and reduce their resistance.

(iv) Food Freezing:

Cryogenic gases are used in transportation of large masses of frozen food, when very large quantity of food must be transported to regions like war field, earthquake hit regions etc., they must be stored for.

(v) Vaccines:

The freezing of biotechnology products like vaccines require nitrogen freezing systems.

Space station:

A space station is an artificial structure designed for humans to live and work in outer space for a period of time.

Current and recent-history space stations are designed for medium-term living in orbit, for periods of weeks, months or even years. The only space stations are Almaz and Salyut series, Sky lab and Mir.

Space stations are used to study the effects of long-space flight on the human

body. It provides platforms for greater number and length of scientific studies than available on other space vehicles. Space stations have been used for both military and civilian purposes. The last military-used space station was Salyut 5, which was used by the Almaz program of the Soviet Union in 1976 and 1977.

Broadly speaking the space stations so for launched has been of two types. Salyut and Skylab have been “monolithic.” They were constructed and launched in one piece, and then manned by a crew later. As such, they generally contained all their supplies and experimental equipment when launched, and were considered “expended”, and then abandoned, when these were used up.

Starting with Salyut 6 and Salyut 7, a change was seen. These were built with two docking ports. They allowed a second crew to visit, bringing a new space craft with them.

This allowed for a crew to man the station continually, sky lab was also equipped with two docking ports, but the extra port was never utilized. The presence of the second port on the new station allowed progress supply vehicle to be docked to the station, meaning that fresh supplies could be brought to aid long-duration missions.

The second group, Mir and the International Space Station (ISS), have been modular; a core unit was launched, and additional modules, generally with a specific role, were later added to that. (on Mir they were usually launched independently, whereas on the ISS most are brought by the Space Shuttle). This method allows for greater flexibility in operation. It removes the need for a single immensely powerful launch vehicle. These stations are also designed from the outset to have their supplies provided by logistical support, which allows for a longer lifetime at the cost of requiring regular support launches.

These stations have various issues that limit their long-term habitability, such as very low recycling rates, relatively high radiation levels and a lack of gravity. Some of these problems cause discomfort and long-term health effects.

Future space habitats may attempt to address these issues, and are intended for long-term occupation. Some designs might even accommodate large number of people, essentially “cities in space” where people would make their homes. No such design has yet been constructed, even for a small station; the current (2010) launch costs are not economically or politically viable.

The People’s Republic of China is expected to launch its space station named Tiangong 1, in the first half of 2011. This would make China the third country to launch a space station.

EVALUATION

PART A

1. The acceleration in a body is due to ___________.

   (balanced force, un-balanced force, electro static force)

2. The physical quantity which is equal to rate of change of momentum is (displacement, acceleration, force, impulse)

3. The momentum of a massive object at rest is ________.

   (very large, very small, zero, infinity)

4. The weight of 50 kg person at the surface of earth is _________.

   (50 N, 35 N, 380 N, 490 N)

5. The freezing of biotechnology products like vaccines require _________ freezing systems.

   (Helium, Nitrogen, Ammonia, Chlorine)

PART – B

1. From the following statements write down that which is not applicabel to mass of an object

   a. It is a fundamental quantity

   b. It is measured using physical balance. c. It is measured using spring balance.

2. Fill in the blanks.

a) Force = mass x acceleration, then momentum = ____?______

b) Liquid hydrogen is for rocket, then—— —— for MRI.

3. The name of some organisations which are associated with Chandrayan-I mission are given below. but some of them are not. List out the wrong ones.

(ISRO, BARC, NASA, ESA, WHO, ONGC)

4. Correct the mistakes, if any, in the following statements.

   a. One newton is the force that produces an acceleration of 1 ms^{-2} in an object of 1 gram mass.

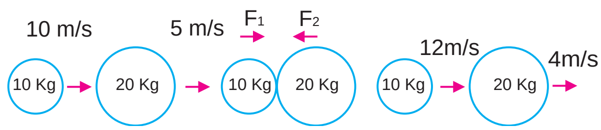
   b. Action and reaction is always acting on the same body.

5. The important use of cryogenics is cryogenic fuels. What do you mean by cryogenic fuels?

6. As a matter of convention, an anticlockwise moment is taken as _________ and a clockwise moment is taken as _________.

PART – C

1. a) Newton's first law of motion gives a qualitative definition of force. Justify.



b) The figure represents two bodies of masses 10 kg and 20 kg and moving with an initial velocity of 10 ms^{-1} and 5 ms^{-1} respectively. They are colliding with each other. After collision they are moving with velocities 12 ms^{-1} and 4 ms^{-1} respectively. The time of collision be .2 s. Then calculate F_1 and F_2.

2. a) Space stations are used to study the effects of long-space flight on the human body. justify.

b) $F=G\, m_1\, m_2 / d^2$ is the mathematical form of Newton's law of gravitation, G - gravitational constant, m_1 m_2, are the masses of two bodies separated by a distance d, then give the statement of Newton's law of gravitation.

FURTHER REFERENCE

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2. College Physics by : **R.L.Weber, K.V. Manning,** Tata McGraw Hill

Websites: www.brittannica.com | www.zonaland education.com | www.wiki.animers.com

Chapter 16

ELECTRICITY AND ENERGY

16 ELECTRICITY AND ENERGY

Name	:	Michael Faraday
Born	:	22 September 1791
Birth place	:	Newington, England
Died	:	25 August 1867
Best known as	:	Inventor of the first dynamo

Electricity has an important place in modern society. It is a controllable and convenient form of energy for variety of uses in homes, schools, hospitals, industries and so on. What constitutes electricity?

How does it flow in an electric circuit? What are the factors that regulate electricity through an electric circuit?. In this chapter we shall attempt to answer such questions.

16.1. ELECTRIC CURRENT AND CIRCUIT

We are familiar with air current and water current. We know that flowing water constitute water current in rivers. Similarly if the electric charge flows through a conductor (metallic wire), we say that there is an electric current in the conductor. In a torch we know that a battery provide flow of charges or an electric current through a torch bulb to glow. We have also seen that it gives light only when it is switched on. What does a switch do? A switch makes a conducting link between the cell and the bulb***. A continuous and closed path of an electric current is called an electric circuit.*** Now if the circuit is broken anywhere the current stops flowing and the bulb does not glow.

How do we express electric current? ***Electric current is expressed by the amount of charge flowing through a particular area of cross section of a conductor in unit time***. In other words it is the rate of flow of electric charges. In circuit using metallic wires, electrons constitute flow of charges. The direction of electric current is taken as opposite to the direction of the flow of electrons.

If a net charge Q, flows across any cross-section of a conductor in time t, then the current I through the cross-section is

$$I=Q/t$$

The S.I unit of electric charge is ***coulomb*.** This is equivalent to the charge contained in nearly 6×10^{18} electrons. The electric current is expressed by a unit called ***ampere (A),*** named after the French Scientist.

From the above equation,

When Q = 1 C, t = 1s, I=1A.

When one coulomb of charge flows in one second across any cross section of a conductor, the current in it is one ampere. An instrument called ammeter is used to measure current in a circuit.

Example 16.1

A current of 0.75 A is drawn by a filament of an electric bulb for 10 minutes. Find the amount of electric charge that flows through the circuit.

Solution:

Given, I = 0.75 A,

t = 10 minutes = 600 s

We know, $Q = I \times t$

$= 0.75 \text{ A} \times 600 \text{ s}$

Q = 450 C

The Fig.16.1 shows a schematic diagram of an electric circuit comprising battery, bulb, ammeter and a plug key.

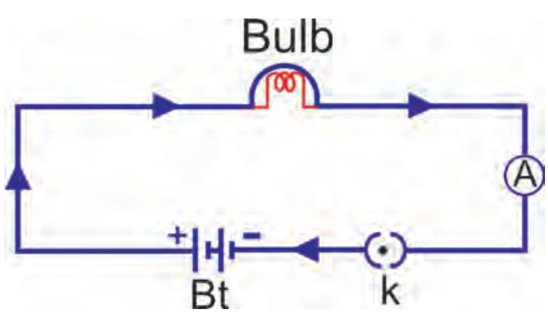


Fig. 16.1 Electric circuit

16.2. ELECTRIC POTENTIAL AND POTENTIAL DIFFERENCE

What makes the electric charge to flow? ter. Charges do not flow in a copper wire by themselves, just as water in a perfectly horizontal tube does not flow. One end of the tube is connected to a tank of water. Now there is a pressure difference between the two ends of the tube. Water flows out of the other end of the tube. For flow of charges in a conducting metallic wire, the electrons move only if there is a difference of electric pressure-called potential difference-along the conductor. This difference of potential may be produced by a battery, consisting of one or more electric cells. When the cell is connected to a conducting circuit element, the potential difference sets the charges in motion in the conductor and produces an electric current.

We define the electric potential difference between two points in an electric circuit carrying some current as the work done to move a unit charge from one point to the other.

Potential difference (V) between two points = work done (W)/charge (Q).

$$V = W/Q$$

The S.I Unit of potential difference is volt (V).

1 volt = 1joule/1coulomb

One volt is the potential difference between two points in a current carrying conductor when 1 joule of work is done to move a charge of 1 coulomb from one point to the other.

The potential difference is measured by means of an instrument called voltmeter.

16.3. CIRCUIT DIAGRAM

The Schematic diagram, in which different components of the circuit are represented by the symbols conveniently used, is called a circuit diagram. Conventional symbols used to represent some of the most commonly used electrical components are given in table 16.1.

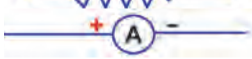
COMPO-NENTS	SYMBOLS
An electric cell	
A battery or a combination of cells	
Plug key or switch (open)	
Plug key or switch (closed)	
A wire joint	
Wires cross-ing without joining	
Electric bulb	 or 
A resistor of resistane R	
Variable resistance or rheostat	 or 
Ammeter	
Voltmeter	

Table 16.1.

Example 16.2.

How much work is done in moving a charge of 5 C across two points having a potential difference 10 V ?

Solution:

Given charge, $Q = 5\ C$

Potential difference, $V = 10\ V$

The amount of work done in moving the charge, $W = V \times Q$

$W = 10\ V \times 5C$ **= 50 J**

16.4. OHM'S LAW

Is there a relationship between the poten-

Name	:	George Simon Ohm
Born	:	16 March 1789
Birth place	:	Erlangen, Germany
Died	:	06 July 1854
Best known for	:	Ohm's law

tial difference across a conductor and the current through it? .Let us explore with an activity.

ACTIVITY 16.1

- Set up a circuit as shown in Fig. 16.2. consisting of a nichrome wire XY of length say 0.5m,an ammeter, a Voltmeter and four cells of 1.5V each.(Nichrome is an alloy of nickel, chromium, manganese and iron metals).
- First use only one cell as the source in the circuit. Note the reading in the ammeter I, for the current and reading of the voltmeter V for the potential difference across the nichrome wire XY in the circuit. Tabulate them in the table given.

ACTIVITY

Repeat the above steps using two, three cells and then four cells in the circuit separately.

- Calculate the ratio of V to I for each pair of potential difference V and current I.

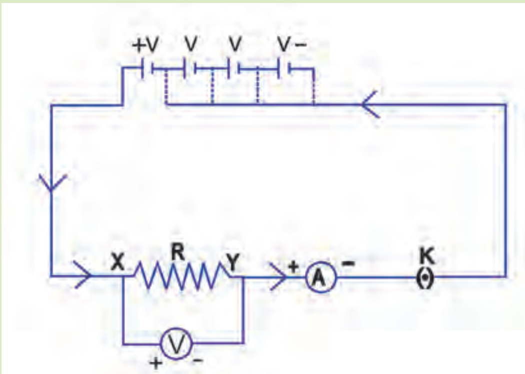


Fig. 16.2

In this activity you will find the ratio V/I is a constant.

In 1827, a German Physicist George Simon Ohm found out the relationship between the current I flowing in a metallic wire and the potential difference across its terminals.

***Ohm's law states that at constant temperature the steady current (I) flowing through a conductor is directly proportional to the potential difference (V) between its ends*.**

$V \propto I$ (or) $V/I = \text{constant}$.

Example 16.3

The potential difference between the terminals of an electric heater is 60 V when it draws a current of 5 A from the source. What current will the heater draw if the potential difference is increased to 120 V?

Solution:

Given the potential difference, V = 60 V

Current, I = 5 A,

According to ohm's law,

$R = V/I = 60\ V / 5\ A = 12\ \Omega$

When the potential difference is increased to 120 V, the current is given by

$I = V/R = 120\ V / 12\ \Omega = 10\ A$

S.No	Number of cells used in the circuit	Current through the nichrome wire I (ampere)	Potential difference across the nichrome wire. V (volt)	V/I (volt/ampere) Ω
1.				
2.				
3.				
4.				
5.				
6.				

16.5. RESISTANCE OF A CONDUCTOR

From Ohm's law, we know

$$V \propto I, \mathbf{V = IR}$$

R is a constant for a given metallic wire at a given temperature and is called its resistance. It is the property of a conductor to resist the flow of charges through it. Its S.I unit is ohm, represented by the Greek letter Ω.

R = V/I, 1 ohm = 1 volt/1 ampere

If the potential difference across the two ends of a conductor is 1volt and the current through it is 1ampere, then the resistance of the conductor is 1 ohm.

ACTIVITY 16.2

- Set up the circuit by connecting four dry cells of 1.5V each in series with the ammeter leaving a gap XY in the circuit, as shown in Fig. 16.3.
- Complete the circuit by connecting the nichrome wire in the gap XY. Plug the key. Note down the ammeter reading. Take out the key from the plug.
- Replace the nichrome wire with the torch bulb in the circuit and find the current through it by measuring the reading of the ammeter.

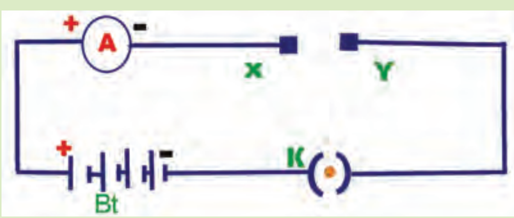


Fig. 16.3

ACTIVITY

- Now repeat the above steps with the LED bulb in the gap XY.
- Are the ammeter readings differ for different components connected in the gap XY? What do the above observations indicate?

16.6. SYSTEM OF RESISTORS

In various electrical circuits we often use resistors in various combinations. There are two methods of joining the resistors together. Resistors can be connected in series or in parallel.

Resistors in series

Consider three resistors of resistances R_1, R_2, R_3 in series with a battery and a plug key as shown in Fig. 16.4.

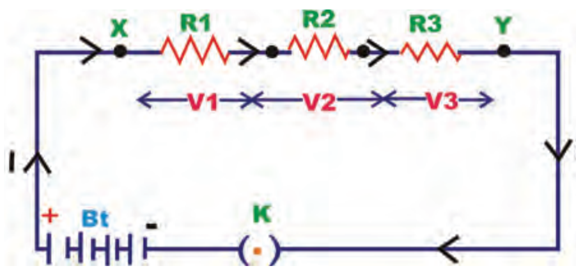


Fig. 16.4

The current through each resistor is the same having a value I. The total potential difference across the combination of resistors in series is equal to the sum of potential difference across individual resistors. That is,

$$V=V_1+V_2+V_3 \qquad (1)$$

It is possible to replace the three resistors joined in series by an equivalent

single resistor of resistance R_s such that the potential difference V across it, and the current I through the circuit remains the same.

Applying ohm's law to the entire circuit we have, V=IR

On applying ohm's law to the three resistors separately we further have

$V_1 = IR_1,\ V_2 = IR_2$ and $V_3 = IR_3$

Substituting these values in equation (1)

$$IR = IR_1+IR_2+IR_3$$

(or) $$\mathbf{R_s = R_1+R_2+R_3}$$

When several resistors are connected in series, the resistance of the combination R_s is equal to the sum of their individual resistances R_1, R_2, R_3 and is thus greater than any individual resistance.

Example 16.4

Two resistances 18 Ω and 6 Ω are connected to a 6 V battery in series. Calculate (a) the total resistance of the circuit, (b) the current through the circuit.

Solution:

(a) Given the resistance, $R_1 = 18\ \Omega$, $R_2 = 6\ \Omega$

The total resistance of the circuit $R_S = R_1 + R_2$

$R_S = 18\,\Omega + 6\,\Omega = \mathbf{24}\,\Omega$

(b) The potential difference across the two terminals of the battery V = 6 V

Now the current through the circuit,

$I = V/R_S = 6\ V / 24\ \Omega$

$\mathbf{= 0.25\ A}$

Resistors in parallel

Consider three resistors having resistances $R_1,\ R_2,\ R_3$ connected in parallel. This combination is connected with a battery and plug key as shown in Fig. 16.5

In parallel combination the potential difference across each resistor is the same having a value V. The total current I is equal to the sum of the separate currents through each branch of the combination.

$$\mathbf{I = I_1+I_2+I_3} \qquad \mathbf{(1)}$$

Let R_p be the equivalent resistance of

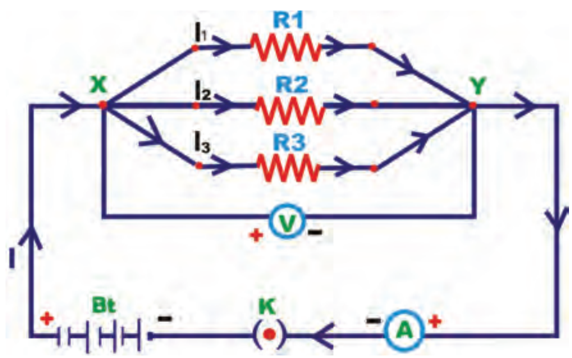


Fig. 16.5

the parallel combination of resistors. By applying ohm's law to the parallel combination of resistors we have $I = V/R_p$

On applying ohm's law to each resistor We have

$I_1 = V/R_1,\ I_2 = V/R_2$ and $I_3 = V/R_3$

Substituting these values in equation (1)

$$V/R_p = V/R_1+V/R_2+V/R_3$$

(or) $$\mathbf{1/R_p = 1/R_1+1/R_2+1/R_3}$$

Thus the reciprocal of the equivalent resistance of a group of resistance joined in parallel is equal to the sum of the reciprocals of the individual resistance.

Example 16.5

Three resistances having the values 5 Ω, 10 Ω, 30 Ω are connected parallel with each other. Calculate the total circuit resistance.

Solution:

Given, $R_1 = 5\ \Omega$, $R_2 = 10\ \Omega$,$R_3 = 30\ \Omega$

These resistances are connected parallel

Therefore, $1 / R_p = 1 / R_1 + 1 / R_2 + 1 / R_3$

$$\frac{1}{R_p} = \frac{1}{5} + \frac{1}{10} + \frac{1}{30} = \frac{10}{30}$$

$$R_p = \frac{30}{10} = \mathbf{3}\ \Omega$$

16.7. HEATING EFFECT OF ELECTRIC CURRENT

ACTIVITY 16.3

- Take an electric cell, a bulb, a switch and connecting wires. Make an electric circuit as shown in Fig. 16.6. By pressing the key allow the current to pass through the bulb.
- The bulb gets heated when current flows continuously for a long time (when the key is on).

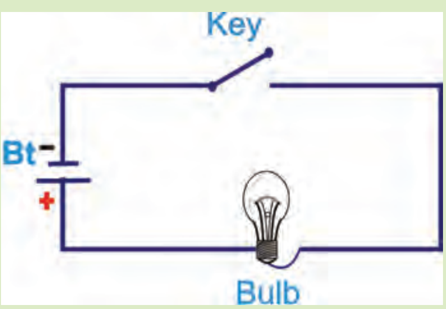


Fig. 16.6

We know that a battery is a source of electrical energy. Its potential difference between the two terminals sets the electrons in motion to flow the current through the resistor. To flow the current, the source has to keep spending its energy. Where does this energy go? What happens when an electric fan is used continuously for longer time? A part of the energy may be consumed into useful work (like in rotating the blades of the fan). Rest of the energy may be expended in heat to raise the temperature of the gadget. If the electric circuit is purely resistive, the source energy continuously gets dissipated entirely in the form of heat. This is known as heating effect of electric current. Heating effect of electric current has many useful appliances. The electric laundry iron, electric toaster, electric oven and electric heater are some of the familiar devices which uses this effect.

16.8. JOULES LAW OF HEATING

Consider a current I flowing through a resistor of resistance R. Let the potential difference across it be V. Let t be the time during which a charge Q flows across. The work done in moving the charge Q through the potential difference V is VQ. Therefore the source must supply energy equal to VQ in time t. Hence the power input to the circuit by the source is

$$P = V\,(Q/t) = VI$$

or the energy supplied through the circuit by the source in time t is P×t, that is VIt. What happens to this energy ex-

pended by the source? This energy gets dissipated in the resistor as heat. Thus for a steady current I, the amount of heat H produced in time t is

$$H = V I t$$

Applying ohm's law we get $H = I^2 Rt$.

This is known as joules law of heating. The law implies that heat produced in a resistor is (1) directly proportional to the square of current for a given resistance, (2) directly proportional to the resistance for a given current, and (3) directly proportional to the time for which the current flows through the resistor.

Example 16.6

A potential difference 20 V is applied across a 4 Ω resistor. Find the rate of production of heat.

Solution:

Given potential difference, $V = 20\ V$

The resistance, $R = 4\ \Omega$

The time, $t = 1\ s$

According to ohm's law, $I = V / R$

$I = 20\ V / 4\ \Omega = 5\ A$

The rate of production of heat, $H = I^2RT$

$H = 5^2 \times 4 \times 1\ J = \mathbf{100\ J}$

16.9. ROLE OF FUSE

A common application of joules heating is the fuse used in electric circuits. It consists of a piece of wire made of metal or an alloy (37% lead, 63% tin). It has high resistance and low melting point. The fuse is connected in series with the device. During the flow of any unduly high electric current the fuse wire melts and protects the circuits and appliances.

16.10. DOMESTIC ELECTRIC CIRCUITS

In our homes, we receive supply of electric power through a main supply (also called mains), either supported through overhead electric poles or by underground cables. One of the wires in the supply, usually with red insulation cover, is called live wire (or positive). Another wire, with black insulation, is called neutral wire (or negative). In our country, the potential differences between the two are 220 V.

At the meter-board in the house, these wires pass into an electricity meter through a main fuse. Through the main switch they are connected to the line wires in the house. These wires supply electricity to separate circuits with in the house. Often, two separate circuits are used, one of 15A current rating for appliances with higher power ratings such as geysers , air coolers ,etc . The other circuit is of 5 A current rating for bulbs, fans, etc. The earth wire which has insulation of green color is usually connected to a metal plate deep in the earth near the house. This is used as a safety measure, especially for those appliances that have a metallic body, for example, electric press, toaster, table fan, refrigerator, etc. The metallic body is connected to the earth wire, which provides a low-resistance conducting path for the current. Thus, it ensures that any leakage of current to the metallic body of the appliance keep its potential to that of the earth, and the user may not get a severe electric shock.

Fig.16.7 gives a schematic diagram of one of the common domestic circuits. In each separate circuit, different appliances can be connected across the live and neutral wires. Each appliance has a separate switch to 'ON'/'OFF' the flow of current through it. In order that each appliance has equal potential difference, they are connected parallel to each other.

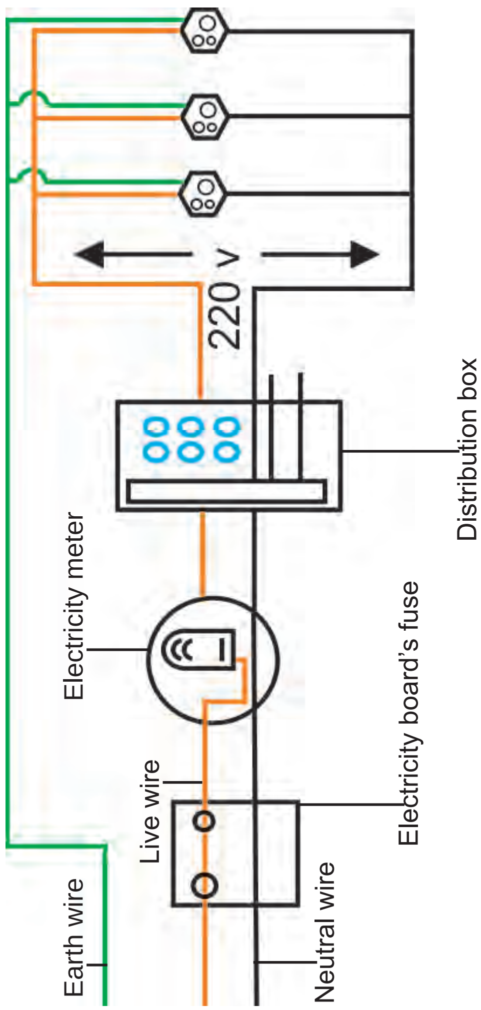


Fig. 16.7

Electric fuse is an important component of all domestic circuits. Over loading can occur when the live wire and the neutral wire come onto direct contact. In such a situation the current in the circuit abruptly increases. This is called short circuiting . The use of an electric fuse prevents the electric circuit and appliance from a possible damage by stopping the flow of unduly high electric current.

16.11. ELECTRIC POWER

We know already that the rate of doing work is power. This is also the rate of consumption of energy. This is also termed as electric power.

The power P is given by P=VI

(or) $\mathbf{P=I^2 R = V^2/R}$

The SI unit of electric power is watt (W). It is the power consumed by a device that carries 1 A of current when operated at a potential difference of 1 V. Thus,

1 W=1 volt $\times$ 1 ampere =1 V A.

The unit watt is very small. Therefore, in actual practice we use a much larger unit called "kilowatt". It is equal to 1000 watt Since electric energy is the product of power and time, the unit of electric energy is, therefore, watt hour (Wh). One watt hour is the energy consumed when one watt of power is used for one hour. The commercial unit of electric energy is kilowatt hour (kWh), commonly known as 'unit'.

1 kWh = 1000watt $\times$ 3600second

= 3.6×10^6 watt second

= 3.6×10^6 joule (J)

Example 16.7

An electric bulb is connected to a 220 V generator. The current is 0.50 A. what is the power of the bulb?

Solution:

Electric generator

voltage,V = 220 V, the current,I = 0.50 A

The power of the bulb,

P = VI = 220 x 0.50 = 110 W

16.12. CHEMICAL EFFECT OF ELECTRIC CURRENT

ACTIVITY 16.4

- Take out carbon rods carefully from two discarded cells.
- Clean their metal caps with sand paper.
- Wrap copper wire around the metal caps of the carbon rods.
- Connect these copper wires in series with a battery and an LED.
- Dip the carbon rods into lemon juice taken in a plastic or rubber bowl.
- Does the bulb glow?
- Does lemon juice conduct electricity?

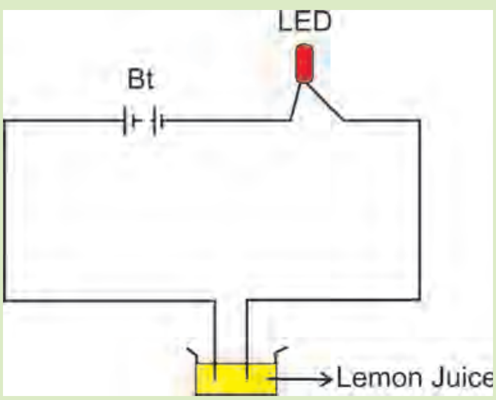


Fig. 16.8

It is observed that lemon juice conduct electricity.

16.13. ELECTROLYSIS- ELECTRO CHEMICAL CELLS

When the current is passed through aqueous or molten solutions of inorganic acids, bases and salts, the conduction of electricity is always accompanied by chemical decomposition of the solutions such solutions are called electrolytes and the phenomenon of the conduction of electricity through electrolytes and chemical decomposition is called electrolysis.

Electro chemical cell

Name	:	Volta
Born	:	18 February 1745
Birth place	:	Como, Italy
Died	:	05 March 1827
Best known for	:	The Italian who built the first battery

The cells in which the electrical energy is derived from the chemical action are called electrochemical cells.

Voltaic cell consists of two electrodes, one of copper and the other of zinc dipped in a solution of dilute sulphuric acid in a glass vessel. This is shown in Fig. 16.9.

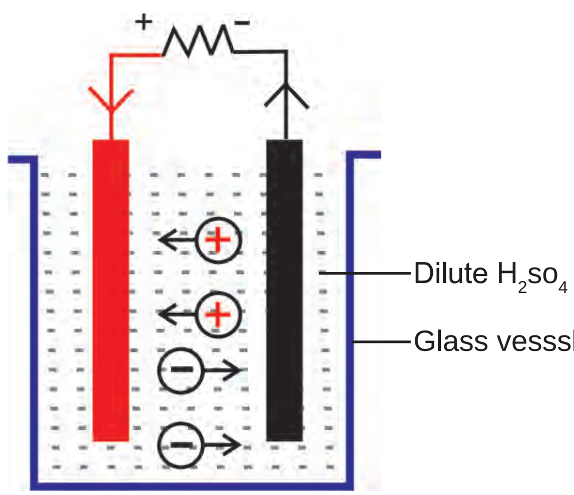


Fig. 16.9

On connecting the two electrodes externally, with a piece of wire, current flows from copper to zinc outside the cell and from zinc to copper inside it. The copper rod of the cell is the positive pole and the zinc rod of the cell is negative pole. The electrolyte is dilute sulphuric acid.

The action of the cell is explained in terms of the motion of the charged ions. At the zinc rod, the zinc atoms get ionized and pass into solution as Zn^{++} ions. This leaves the zinc rod with two electrons more, making it negative. At the same time, two hydrogen ions ($2H^+$) are discharged at the copper rod, by taking these two electrons. This makes the copper rod positive. As long as excess electrons are available on the zinc electrode, this process goes on and a current flows continuously in external circuit. This simple cell is thus seen as a device which converts chemical energy into electrical energy. Due to opposite charges on the two plates, a potential difference is set up between copper and zinc. Copper being at a higher potential than zinc, the difference of potential between the two electrodes is 1.08 V.

16.14. PRIMARY AND SECONDARY CELLS

Primary cell

The cells from which the electric energy is derived by irreversible chemical reaction are called primary cells. The primary cell is capable of giving an emf, when its constituents, two electrodes and a suitable electrolyte, are assembled together. The main primary cells are Daniel cell and Leclanche cell. These cells cannot be recharged. Leclanche cell is discussed here.

1. Leclanche cell

A Leclanche cell consists of a glass vessel which is filled with ammonium chloride solution. Ammonium chloride solution is acting as electrolyte. In it there stands a zinc rod and porous pot containing a carbon rod which is packed round with a mixture of manganese dioxide and powdered carbon. Therefore the carbon rod forms the positive pole and the zinc rod the negative pole.

Ammonium chloride, splits into ammonium and chloride ions. The chloride ions migrate to the zinc rod and deposit their negative charge at the zinc rod. Hence zinc becomes negatively charged and the reaction takes place in which zinc

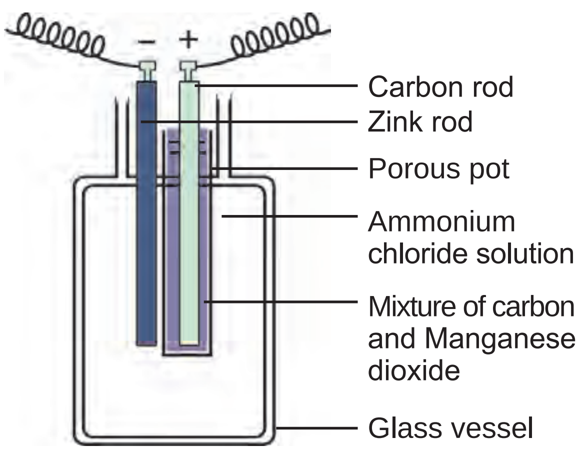


Fig.16.10

is converted to zinc chloride. The ammonium ions migrate to the carbon rod and make it positively charged. When the car-

bon rod and zinc rod are connected by a wire, the current flows from carbon to zinc through the wire. The e.m.f of the cell is about 1.5V.

Secondary cells

The advantage of secondary cell is that they are rechargeable. The chemical reactions that take place in secondary cells are reversible. The active materials that are used up when the cell delivers current can be reproduced by passing current through the cell in opposite direction. The chemical process of obtaining current from a secondary cell is called discharge. The process of reproducing active materials is called charging. One of the most commonly used secondary cell is lead acid accumulator.

Lead-acid accumulator

In a lead-acid accumulator, the anode and cathode are made of lead and lead dioxide respectively. The electrolyte is dilute sulphuric acid. As power is discharged

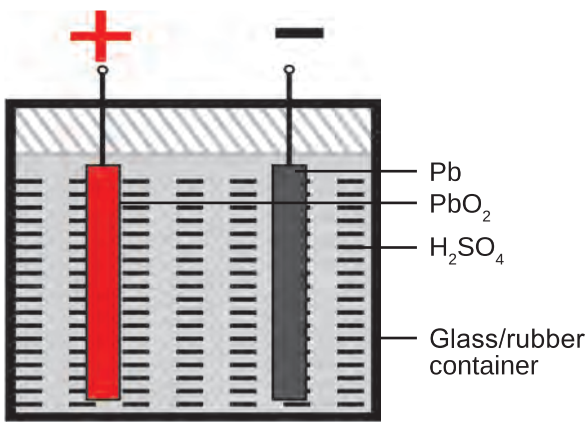


Fig. 16.11

from the accumulator, both the anode and cathode undergoes a chemical reaction that progressively changes them into lead sulphate. When the anode and cathode

are connected by a wire, the current flows from cathode to anode through the wire.

When current is applied to a lead-acid accumulator, the electrochemical reaction is reversed. This is known as recharging of the accumulator. The e.m.f of freshly charged cell is 2.2V.

16.15. SOURCES OF ENERGY

Energy comes from different forms and one can be converted to another. If energy can neither be created nor be destroyed. we should be able to perform endless activities without thinking about energy resources. But we hear so much about the energy crises. What is the reason?

If we drop a plate from a height, the potential energy of the plate is converted mostly to sound energy when it hit's the ground. If we light a candle the chemical energy in the wax is converted to heat energy and light energy on burning.

In these examples we see that energy, in the usable form is dissipated to the surroundings in less usable forms. Hence any source of energy we use to do work is consumed and cannot be used again. We use muscular energy for carrying out physical work, electrical energy for running various appliances, chemical energy for cooking food or running a vehicle, all come from a source. We should know

how to select the source needed for obtaining energy in its usable form, and then only it will be a useful source.

A good source of energy would be one

- Which would do a large amount of work per unit volume of mass?
- Be easily accessible.
- Be easy to store and transport and
- Perhaps most importantly be economical.

16.15.1. Conventional-sources of energy

1. Fossil fuels

In ancient time's wood was the most common source of energy. The energy of flowing water and wind was also used for limited activities. Can you think of some of these uses? The exploitation of coal as a source of energy made the industrial revolution possible. Industrialisation has caused the global demand for energy to grow at a tremendous rate. The growing demand for energy was largely met by the fossil fuels, coal and petroleum. These fuels were formed over millions of years ago and there are only limited reserves. The fossil fuels are non-renewable sources of energy. So we need to conserve them. If we were to continue consuming these sources at such alarming rates we would soon run out of the energy. In order to avoid this alternate source of energy were explored.

Burning fossil fuels has other disadvantages like air pollution, acid rain and production of green house gases.

We will see how various sources of energy can be used to run the turbine and generate electricity in the following sections.

2. Thermal power plant

Large amount of fossil fuels are burnt everyday in power stations to heat up water to produce steam which further runs the turbine to generate electricity. The transmission of electricity is more efficient than transporting coal or petroleum over the same distance. Therefore, many thermal power plants are set up near coal or oil fields. The term thermal power plant is used since fuel is burnt to produce heat energy which is converted into electrical energy.

3. Hydro power plants

Another traditional source of energy was the kinetic energy of flowing water or the potential energy of water at a height. Hydro power plants convert the potential energy of falling water into electricity. Since there are very few water falls which could be used as a source of potential energy, hydro power plants are associated with dams. In the last century, a large number of dams were built all over the world. As we can see ,a quarter of our energy requirements in India is met by hydro power plants. In order to produce hydro electricity, high-rise dams are constructed on the river to obstruct the flow of water and there by collect water in larger reservoirs. The water level rises and in this process the kinetic energy of flowing water gets transformed into potential energy. The water from the high level in the dam

is carried through the pipes, to the turbine, at the bottom of the dam Fig.16.12. since the water in the reservoir would be refilled each time it rains(hydro power is a renewable source of energy) we would not have to worry about hydro electricity sources getting used up the way fossil fuels would get finished one day.

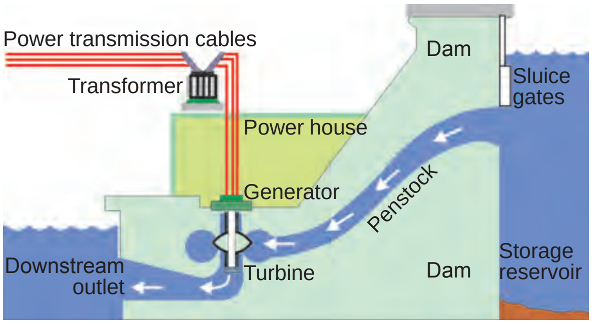


Fig. 16.12

4. Bio-mass

We mentioned earlier that wood has been used as a fuel for a long time. If we can ensure that enough trees are planted, a continuous supply of fire-wood can be assured. You must also be familiar with the use of cow-dung cakes as a fuel. Given the large-stock published in India, this can also assure us a steady source of fuel. Since these fuels are plant and animal products, the source of these fuels is set to be bio-mass. These fuels, however, do not produce much heat on burning and a lot of smoke is given out when they are burnt. Therefore, technological inputs to improve the efficiency of these fuels are necessary. When wood is burnt in a limited supply of oxygen, water and volatile materials present in it get removed and charcoal is left behind as the residue. Charcoal burns without flames, is comparatively smokeless and has higher heat generation efficiency.

Similarly, cow-dung, various plant materials like the residue after harvesting the crops, vegetable wastes and sewage are decomposed in the absence of oxygen to give bio-gas. Since the starting material is mainly cow-dung, it is popularly known as 'go bar-gas'. The 'go bar-gas' plant structure is shown in Fig. 16.13.

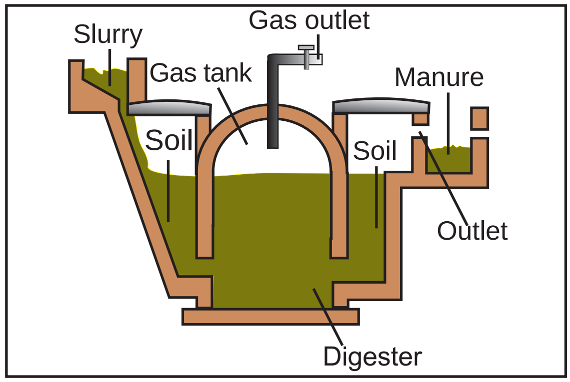


Fig 16.13

5. Wind energy

The kinetic energy of the wind can be used to do work. This energy was harnessed by wind mills in the past to do mechanical work. For example, in a water-lifting pump, the rotatory motion of windmill is utilized to lift water from a well. Today, wind energy is also used to generate electricity. A wind mill essentially consists of a structure similar to a large electric fan that is erected at some height on a rigid support.

To generate electricity, the rotatory motion of the windmill is used to turn the turbine of the electric generator. The output of a single windmill is quiet small and cannot be used for commercial purposes. Therefore, a number of windmills are erected over a large area, which is known as wind energy farm. The energy output of each windmill in a farm is coupled to-

gether to get electricity on a commercial scale.

Wind energy is a environment-friendly and efficient source of renewable energy. It requires no recurring expenses for the production of electricity. The wind speed should be higher

Fig. 16.14

than 15 km per hour to maintain the required speed of the turbine. *Fig. 16.14.*

16.15.2. Non-conventional sources of energy

Our life-styles are changing; we use machines to do more and more of our tasks. Therefore our demand for the energy increases. We need to look for more and more sources of energy. We could develop the technology to use the available sources of energy more efficiently and also look to new sources of energy. We shall now look at some of the latest sources of energy.

1. Solar energy

The sun has been radiating an enormous amount of energy at the present

ACTIVITY 16.5

- Find out from your grand-parents or other elders
- (a) How did they go to school?
- (b) How did they get water for their daily needs when they were young?
- (c) What means of entertainment did they use?
- Compare the above answers with how you do these tasks now.
- Is there a difference? If yes, in which case more energy from external sources is consumed?

rate for nearly 5 billion years and will continue radiating at that rate for about 5 billion years more. Only a small part of solar energy reaches the outer layer of the earth atmosphere. Nearly half of it is absorbed while passing through the atmosphere and the rest reaches the earth's surface.

A black surface absorbs more heat than any other surface under identical conditions. Solar cookers and solar water heaters use this property in their working. Some solar cookers achieve a higher temperature by using mirrors to focus the rays of the sun. solar cookers are covered with a glass plate.

These devices are useful only at certain times during the day. This limitation of using solar energy is overcome by using solar cells that convert solar energy into electricity. A large number of solar cells are combined in a arrangement called solar

ACTIVITY 16.6

- Take two conical flasks and paint one white and the other black. Fill both with water.
- Place the conical flask in direct sunlight for half an hour to one hour.
- Touch the conical flasks. Which one is hotter? You could also measure the temperature of the water in the two conical flasks with a thermometer.
- Can you think of ways in which this finding could be used in your daily life?

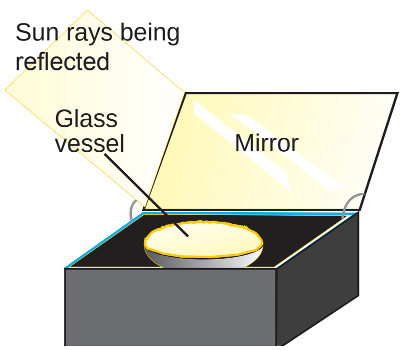


Fig. 16.15

cell panel that can deliver enough electricity for practical use *Fig. 16.16.* The principal advantages associated with solar cells are that they have no moving part, require little maintenances. Another advantage is that they can be set up in remote areas in which laying of power transmission line may be expensive.

ACTIVITY 16.7

- Study the structure and working of a solar cooker or a solar water-heater, particularly with regard to how it is insulated and maximum heat absorption is ensured.
- Design and built a solar cooker or water-heater using low-cost material available and check what temperature are achieved in your solar system.
- Discuss what would be the advantages and limitations of using the solar cooker or water-heater.

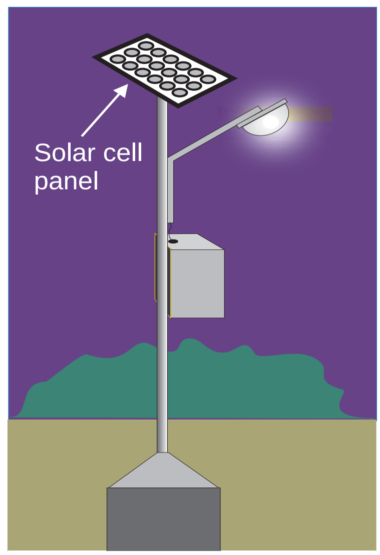


Fig 16.16

16.15.3. Nuclear energy

How is nuclear energy generated? In a process called nuclear fission, the nucleus of a heavy atom (such as uranium, plutonium or thorium), when bombarded with low-energy neutrons, can be split apart into lighter nuclei. When this is done, a tremendous amount of energy is released if the mass of the original nucleus is just a little more than the sum of the masses of the individual products. The fission of an atom or uranium, for example, produces 10 million times the energy produced by the combustion of an atom of carbon from

PHYSICS

coal. In a nuclear reactor designed for electric power generation sustained fission chain reaction releases energy in a controlled manner and the released energy can be used to produce steam and further generate electricity.

16.15.4. Radioactivity

Name	:	Henry Becquerel
Born	:	15 December 1852
Birth place	:	Paris, France
Died	:	25 August 1908
Best known for	:	Discovery of radioactivity

The phenomenon of radioactivity was discovered by Henri Becquerel in 1896. He found that a photographic plate wrapped in a black paper was affected by certain penetrating radiations emitted by uranium salt. Rutherford showed later that the radiations from the salt were capable of ionizing a gas. The current produced due to the ions was taken as a measure of activity of the compound.

A few years later Madame Marie Curie and her husband Pierre Curie discovered the highly radioactive elements radium and polonium. The activity of the material has been shown to be the result of the three different kinds of radiations, α, β, and γ.

The phenomenon of spontaneous emission of highly penetrating radiations such as α, β, and γ rays by heavy elements having atomic number greater than 82 is called radioactivity and the substances which emit these radiations are called radioactive elements.

The radioactive phenomenon is spontaneous and is unaffected by any external agent like temperature, pressure, electric and magnetic fields etc.

16.15.5. Nuclear fission and nuclear fusion

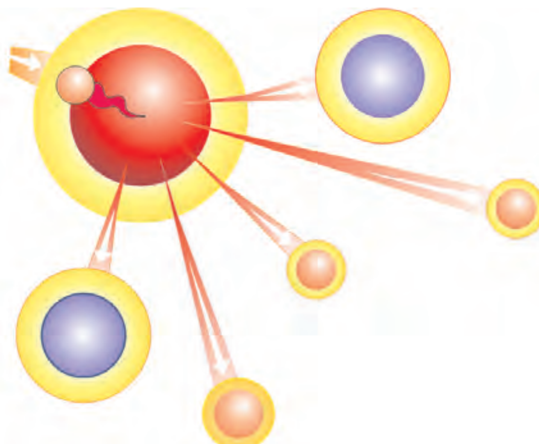
1. Nuclear fission

In 1939, German scientists Otto Hahn and Strassman discovered that when uranium nucleus is bombarded with a neutron, it breaks up into two fragments of comparable masses with the release of energy.

The process of breaking up of the nucleus of a heavier atom into two fragments with the release of large amount of energy is called nuclear fission. The fission is accompanied of the release of neutrons. The fission reactions with ${}_{92}U^{235}$ are represented as

$${}_{92}U^{235} + {}_{0}n^{1} \rightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + 3\,{}_{0}n^{1} + 200 \text{ Me V}$$

In the above example the fission reaction is taking place with the release of 3 neutrons and 200 Million electron volt energy.



The process of fission

Fig. 16.17

2. Nuclear fusion

Nuclear fusion is a process in which two or more lighter nuclei combine to form a heavier nucleus. The mass of the product is always less than the sum of the masses of the individual lighter nuclei. According to Einstein's mass energy relation $E = mc^2$, the difference in mass is converted into energy. The fusion process can be carried out only at a extremely high temperature of the order of 10^7 K because, only at these very high temperatures the nuclei are able to overcome their mutual repulsion. Therefore before fusion, the lighter nuclei must have their temperature raised by several million degrees. The nuclear fusion reactions are known as thermo nuclear reactions.

A suitable assembly of neutron and deuteron and triton is arranged at the sight of the explosion of the atom bomb. Favorable temperature initiates the fusion of light nuclei in an uncontrolled manner. This releases enormous amount of heat energy. This is the hydrogen bomb.

The fusion reaction in the hydrogen bomb is $_1H^2 + {_1H^3} \rightarrow {_2He^4} + {_0n^1}$ + **Energy**

Example: 16.8

Calculate the energy produced when 1 kg of substance is fully converted into energy.

Solution:

Energy produced,	$E = mc^2$
Mass,	$m = 1$ kg
Velocity of light,	$c = 3\times10^8$ m s^{-1}
	$E = 1\times(3\times10^8)^2$
	$E = 9 \times 10^{16}$ J

16.15.6. Nuclear Reactivity Advantantages

Nuclear reactivity is a measure of the departure of a reactor from criticality. It is a useful concept to predict how the neutron population of a reactor will change over time.

If a reactor is exactly critical, that is, the neutron production is exactly equal to the neutron destruction, then the reactivity is zero. If the reactivity is positive, then the reactor is super critical. If the reactivity is negative, then the reactor is sub critical.

16.15.7. Hazards of nuclear energy

α, β and γ radiations are all ionizing radiations. These radiations cause a change in the structure of molecules in cells, disturbs the normal functioning of the biological system. The extent to which the human organism is damaged depends upon

1. The dose and the rate at which the radiation is given and

2. The part of the body exposed to it. The damage may be either pathological or genetic.

The radiation exposure is measured by the unit called roentgen(R). One roentgen is defined as the quantity of radiation which produces 1.6×10^{12} pairs of ion in 1 gram of air.

Safe limit of receiving the radiation is about 250 milli roentgen per week.

The following precautions are to be taken for those, who are working in radiation laboratories.

(i) Radioactive materials are kept in thick-walled lead container.

(ii) Lead aprons and lead gloves are used while working in hazardous area.

(iii) A small micro-film badge is always worn by the person and it is checked periodically for the safety limit of radiation.

(iv) Nuclear devices can be operated using remote control system.

(v) Clean up contamination in the work area promptly.

16.15.8. SCIENCE TODAY - Energy from seas

1. Tidal energy

Due to the gravitational pull of mainly the moon on the spinning earth, the level of the water in the sea rises and falls. If you live near the sea or ever travel to some place near the sea, try and observe how the sea-level changes during the day. The phenomenon is called high and low tides and the difference in sea-levels gives us tidal energy. Tidal energy is harnessed by constructing a dam across a narrow opening to the sea. A turbine fixed at the opening of the dam converts tidal energy to electricity. Fig. 16.18. As you can guess, the locations where such dams can be built are limited.

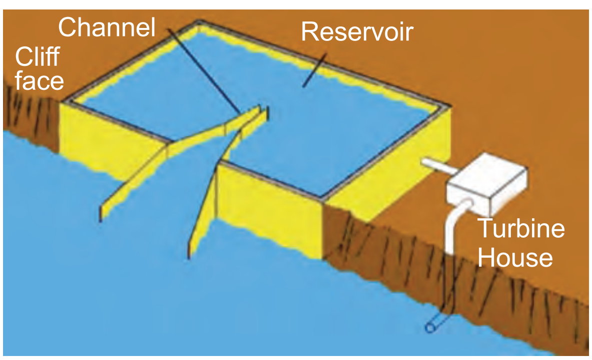


Fig. 16.18

2. Wave energy

Similarly, the kinetic energy possessed by huge waves near the sea-shore can be trapped in a similar manner that generates electricity. The waves are generated by strong winds blowing across the sea. Wave energy would be a viable proposition only where waves are very strong. A wide variety of devices has been developed to trap wave energy for rotation of turbine and production of electricity. Fig.16.19

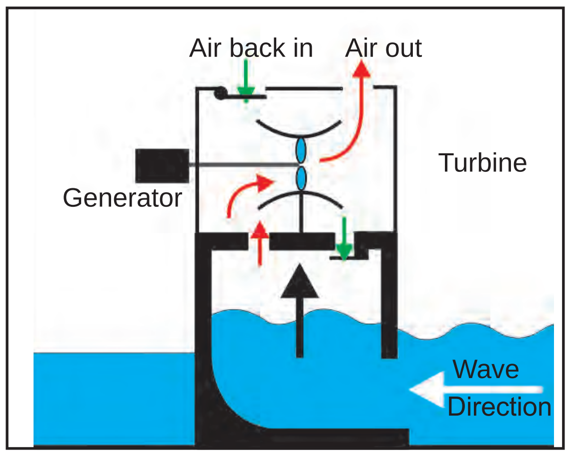


Fig. 16.19

3. Ocean thermal energy

The water at the surface of the sea or ocean is heated by the sun while the water in deeper sections is relatively cooled. This difference in temperature is exploited to obtain energy in ocean-thermal-energy conversion plants. These plants can operate if the temperature difference between the water at the surface and water at depths up to 2 kilometers is 293 K (20° C) or more . The warm surface-water is used

CHAPTER 16

to boil a volatile liquid like ammonia. The vapors of liquid then used to run the turbine of generator. The cooled water from the depth of the ocean is pumped up and condense vapor again to liquid. Fig.16.20.

The energy potential from the sea (tidal energy, wave energy and ocean thermal energy) is quiet large, but efficient commercial exploitation is difficult.

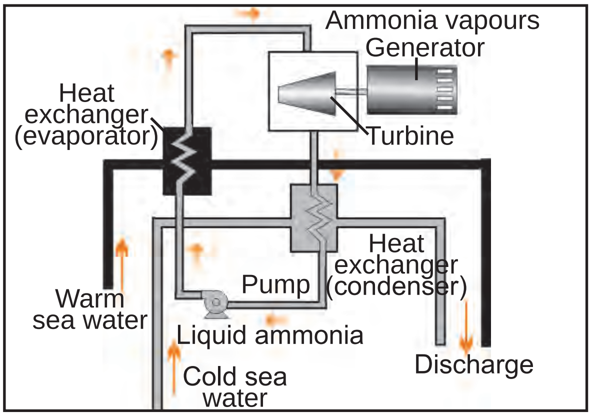


Fig. 16.20

EVALUATION

PART A

1. The potential difference required to pass a current 0.2 A in a wire of resistance 20 ohm is __________.(100 V, 4 V, 0.01 V, 40 V)

2. Two electric bulbs have resistances in the ratio 1 : 2. If they are joined in series, the energy consumed in these are in the ratio __________.(1 : 2, 2 : 1, 4 : 1, 1 : 1)

3. Kilowatt-hour is the unit of ___________. (potential difference, electric power, electric energy, charge)

4. _________ surface absorbs more heat than any other surface under identical conditions. (White, rough, black, yellow)

5. The atomic number of natural radioactive element is __________. (greater than 82, less than 82, not defined, atleast 92)

PART B

1. From the following statements write down that which does not represent ohm's law.
   a) current / potential difference = constant
   b) potential difference / current = constant
   c) current = resistance x potential difference

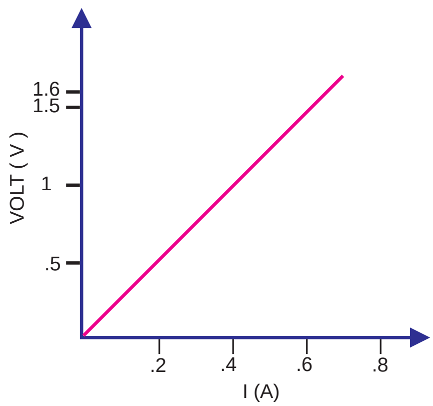
2. Fill in the blanks
   a) Potential difference : voltmeter, then: current ___________.
   b) power plant : conventional source of energy then solar energy ______.

3. In the list of sources of energy given below, some of them are wrong. List out the wrong ones. (Wind energy, solar energy, hydro electric power, nuclear energy, tidal energy, wave energy, geo-thermal energy.)

4. Correct the mistakes, if any, in the following statements.
   a) A good source of energy would be one which would do a small amount of work per unit volume of mass.
   b) Any source of energy we use to do work is consumed and can be used again.

5. The schematic diagram, in which different components of the circuit are represented by the symbols conveniently used, is called a circuit diagram. What do you mean by the term components?

6. Following graph was plotted between V and I values.What would be the values of V / I ratios when the potential difference is 0.8 V and 1.2 V.



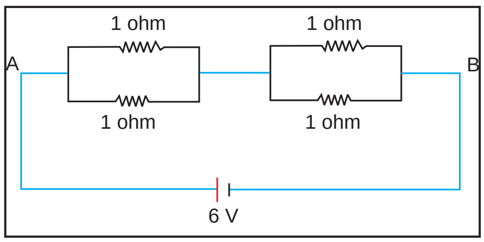
7. We know that γ – rays are harmful radiations emitted by natural radio active substances.
   a) Which are other radiations from such substances?z
   b) Tabulate the following statements as applicable to each of the above radiations

   They are electromagnetic radiation. They have high penetrating power. They are electrons. They contain neutrons.

8. Draw the schematic diagram of an electric circuit consisting of a battery of two cells of 1.5V each, three resistance of 5 ohm, 10 ohm and 15 ohm respectively and a plug key all connected in series.

9. Fuse wire is made up of an alloy of ____________ which has high resistance and ________.

10. Observe the circuit given below and find the resistance across AB.



11. Complete the table choosing the right terms from within the brackets. (zinc, copper, carbon, lead, leadoxide, aluminium.)

+ ve electrode	Danial cell	
- ve electrode	Lechlechne cell	

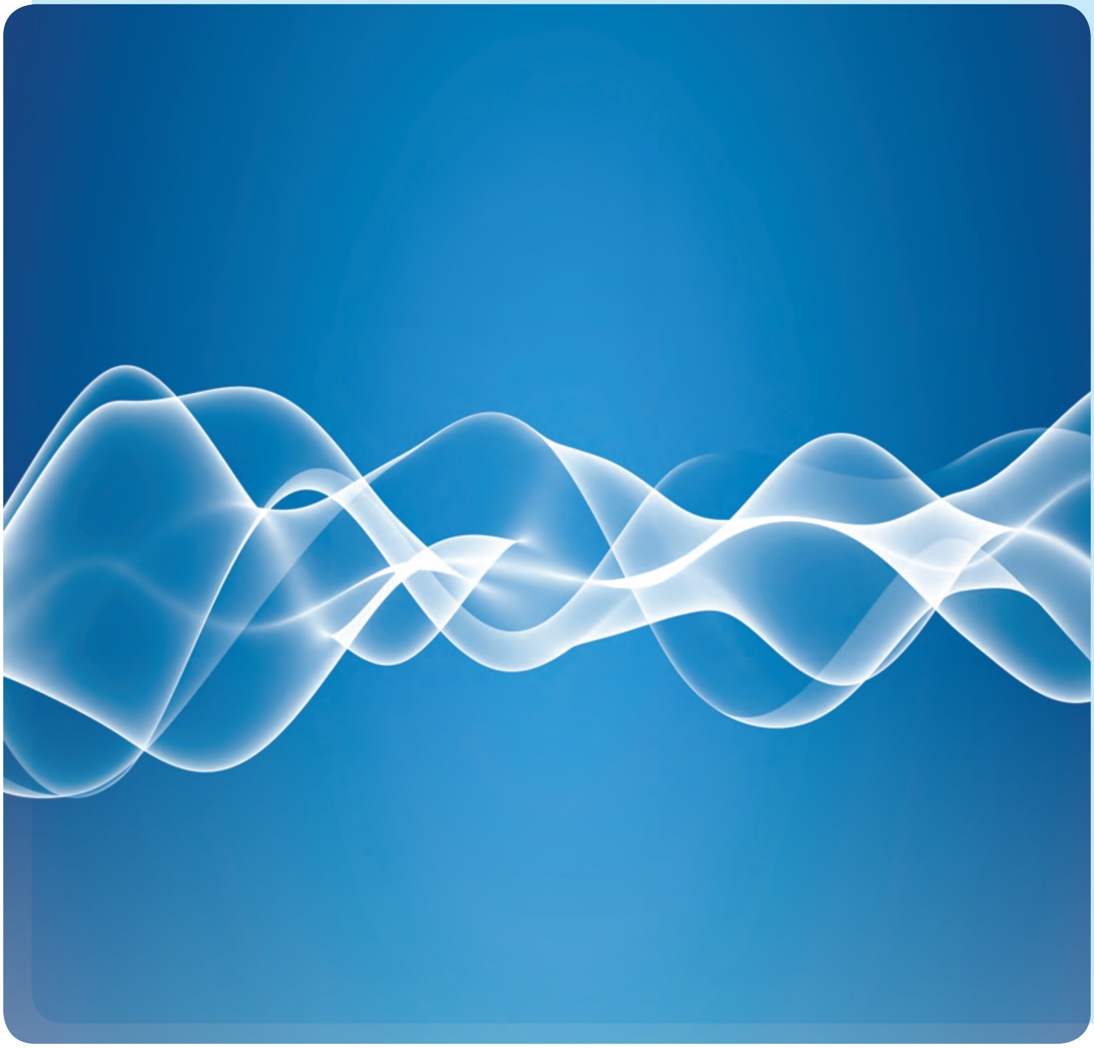
FURTHER REFERENCE

Books : 1. Electricity and Magnetism, by **D.C Tayal** Himalayam publishing house.

2. Sources of energy, by **C. Walker,** Modern curriculam press.

Website : www.reprise.com, www.wikipedia.org

Chapter 17



MAGNETIC EFFECT OF ELECTRIC CURRENT AND LIGHT

17. MAGNETIC EFFECT OF ELECTRIC CURRENT AND LIGHT

Name	: Oersted
Born	: 14 August 1777
Birth place	: Langeland Denmark
Died	: 9 March 1851
Best known for	: The study of electromagnetism

17.1. MAGNETIC FIELD AND MAGNETIC LINES OF FORCE

We are familiar with the fact that a compass needle gets deflected when brought near a bar magnet. Why does a compass needle get deflected?

ACTIVITY 17.1

- Fix a sheet of white paper on a drawing board using some adhesive material.
- Place a bar magnet in the centre of it.
- Sprinkle some iron fillings uniformly around the bar magnet (Fig 17.1).
- A salt-Sprinkler may be used for this purpose.
- Now tap the board gently.
- What do you observe?

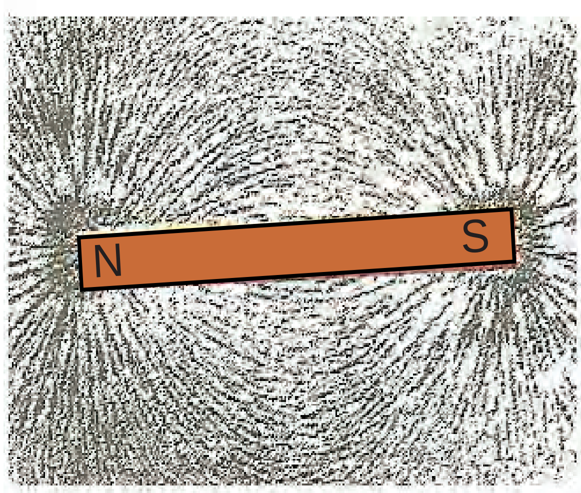


Fig. 17.1

The iron fillings arrange themselves in a pattern as shown in Fig. 17.1. Why do the iron fillings arrange in such a pattern? What does this pattern demonstrate? The magnet exerts its influence in the region surrounding it. Therefore the iron fillings experience a force. The force thus exerted makes iron fillings to arrange in a pattern. The region surrounding the magnet, in which the force of the magnet can be detected, is said to have a ***magnetic field.*** The lines along which the iron fillings align themselves represent ***magnetic lines of force.***

ACTIVITY 17.2

- Take a small compass and a bar magnet.
- Place the magnet on a sheet of white paper fixed on a drawing board, using some adhesive material.
- Mark the boundary of the magnet.
- Place the compass near the north pole of the magnet. How does it behave? The south pole of the needle points towards the north pole of the magnet. The north pole of the compass is directed away from the north pole of the magnet.
- Mark the position of two ends of the needle.
- Now move the needle to a new position such that its south occupies the position previously occupied by its north pole.
- In this way, proceed step by step till you reach the south pole of the magnet as shown
- Join the points marked on the paper by a smooth curve. This curve represents a field line.
- Repeat the above procedure and draw as many lines as you can. You will get a pattern shown in Fig.17.2.These lines represent the magnetic field around the magnet. These are known as magnetic field lines.
- Observe the deflection of the compass needle as you move it along the field line. The deflection increases as the needle is moved towards the pole.

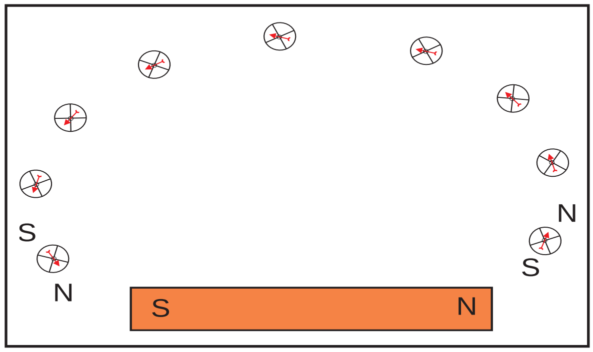


Fig 17.2

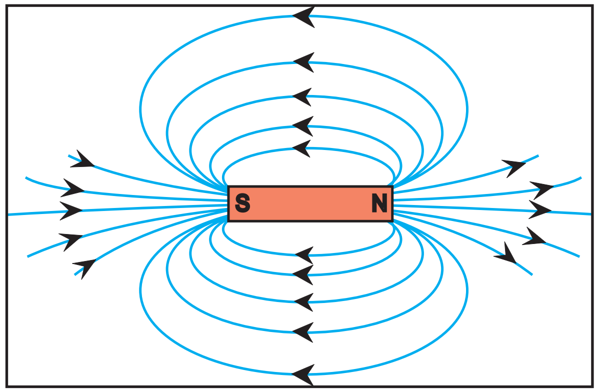


Fig 17.3

Magnetic field is a quantity that has both magnitude and direction. The direction of the magnetic field is taken to be the direction in which a north pole of the compass needle moves inside it. Therefore it is taken by convention that the field lines emerge from the north pole and merge at the south pole as shown in Fig.17.3. Inside the magnet, the direction of field lines is from its south pole to its north pole. Thus the magnetic field lines are closed curves. No two field-lines are found to cross each other.

17.2. MAGNETIC FIELD DUE TO CURRENT CARRYING CONDUCTOR

In the activity 17.3 we have seen that electric current through a metallic conductor

ACTIVITY 17.3

- Take a straight thick copper wire and place it between the points X and Y in an electric circuit, as shown in Fig..17.4. The wire XY is kept perpendicular to the plane of the paper.
- Horizontally place a small compass near this copper wire. See the position of its needle.
- Pass the current through the circuit by inserting the key into the plug.
- Observe the change in the position of the compass needle and the direction of deflection.
- Replace the cell connection in the circuit so that the direction of the current in the copper wire changes.
- Observe the change in the direction of deflection of the needle.

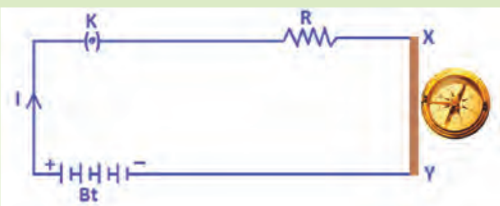


Fig 17.4

produces a magnetic field around it. If the current flows in one direction (from X to Y), the north pole of the compass needle would move towards the east. If the current flows in opposite direction (from Y to X), you will see that the needle moves in opposite direction, that is towards the west. It means that the direction of magnetic field produced by the electric current depends upon the direction of flow of current.

17.2.1. Magnetic field due to current carrying straight conductor

What determines the pattern of the magnetic field generated by current through a conductor? Does the pattern depend on the shape of the conductor? We shall investigate this with an activity.

ACTIVITY 17.4

- Take a battery (12 V), a variable resistance (rheostat), an ammeter (0-5A), a plug key, and a long straight thick copper wire.
- Insert the thick wire through the centre, normal to the plane of a rectangular cardboard. Take care that the cardboard is fixed and does not slide up or down.
- Connect the copper wire vertically between the points X and Y, as shown in Fig 17.5(a), in series with the battery, a plug key, ammeter and a rheostat.
- Sprinkle some iron fillings uniformly on the cardboard. (you may use a salt sprinkler for this purpose).
- Keep the variable of the rheostat at a fixed position and note the current through the ammeter.
- Close the key so that the current flows through the wire. Ensure that the copper wire placed between the points X and Y remains vertically straight.

- Gently tap the cardboard a few times. Observe the pattern of the iron fillings. You would find that the iron fillings align themselves showing a pattern of concentric circles around the copper wire, Fig 17.5(b).
- What do these concentric circles represent? They represent the magnetic field lines.
- How can the direction of the magnetic field be found? Place a compass at a point (say P) over a circle. Observe the direction of the needle. The direction of the north pole of the compass needle would give the direction of the field lines produced by the electric current through the straight wire at point P. Show the direction by an arrow.
- Does the direction of magnetic field lines get reversed if the direction of current through the straight copper wire is reversed? Check it.

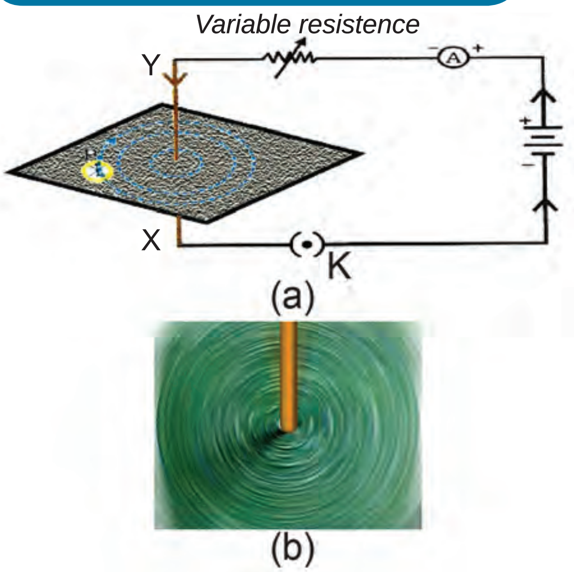


Fig.17.5

What happens to the deflection of the compass needle placed at a given point if the current in the copper wire is changed? We find that the deflection in the needle also changes. In fact, if the current is increased, the deflection also increases. It indicates that the magnitude of the magnetic field produced at a given point increases as the current through the wire, increases.

What happens to the deflection of the needle if the compass is moved from the copper wire but the current through the wire remains the same? To see this, now place the compass at a farther point from the conducting wire. What change do you observe? We see that the deflection in the needle decreases. Thus the magnetic field produced by the given current in the conductor decreases as the distance from it increases. From Fig.17.5 (b), it can be noticed that the concentric circles representing the magnetic field around a current-carrying straight wire become larger and larger as we move away from it.

17.2.2. Magnetic field due to current carrying circular loop

We have so far observed the pattern of the magnetic field lines produced around a current-carrying straight wire. Suppose this straight wire is bent in the form of a circular loop and current is passed through it, how would the magnetic field lines look like?

We know that the magnetic field produced by a current- carrying straight wire depends inversely on the distance

ACTIVITY 17.5

- Take a rectangular cardboard having two holes. Insert a circular coil having large number of turns through them, normal to the plane of the cardboard.
- Connect the ends of the coil in series with a battery, a key and rheostat, as shown in Fig.17.6.
- Sprinkle iron fillings uniformly on the cardboard.
- Plug the key.
- Tap the cardboard gently a few times. Note the pattern of the iron fillings that emerges on the cardboard.

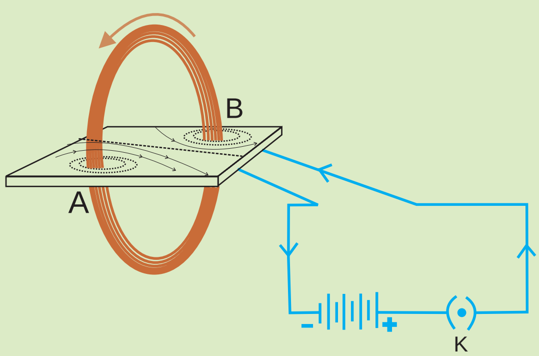


Fig.17.6

from it. Similarly at every point of a current-carrying circular loop, the concentric circles representing the magnetic field around it becomes larger and larger as we move away from the wire (Fig. 7.7).

By the time we reach the centre of the circular loop, the arcs of these big circles would appear as straight lines. Every point on the wire carrying current would give rise to the magnetic field appearing as straight lines at the centre of the loop.

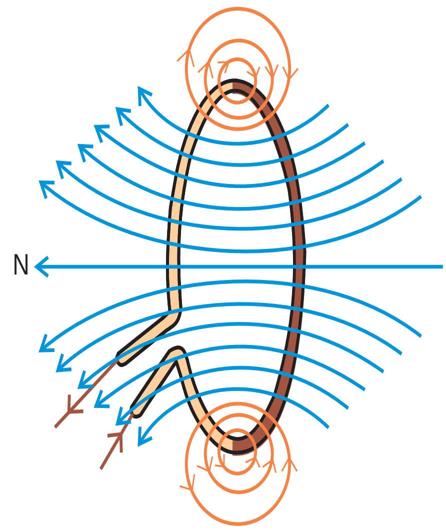


Fig.17.7

We know that the magnetic field produced by a current- carrying conductor at a given point, depends directly on the current passing through it. Therefore, if there is a circular coil having n turns, the field produced is n times as large as produced by a single turn. This is because the current in each circular turn has the same direction, and the field due to each turn then just adds up.

17.3. FORCE ON A CURRENT CARRYING CONDUCTOR IN A MAGNETIC FIELD

We know that an electric current flowing through a conductor produces a magnetic field. The field so produced exerts a force on a magnet placed in the vicinity of a conductor. French scientist Andre Marie Ampere suggested that the magnet must also exert an equal and opposite force on the current carrying conductor. The force due to a current carrying conductor can be demonstrated through the following activity.

ACTIVITY 17.6

- Take a small aluminium rod AB of about 5 cm. using two connecting wires suspend it horizontally from a stand as shown in Fig. 17.8.
- Place a horse-shoe magnet in such a way that the rod lies between two poles with the magnetic field directed upwards. For this put the North Pole of the magnet vertically below and South Pole vertically above the aluminium rod.
- Connect the aluminium rod in series with a battery, a key and a rheostat.
- Now pass a current through the aluminium rod from end B to A.
- What do you observe? It is observed that the rod is displaced towards the left. You will notice that the rod gets displaced.
- Reverse the direction of current flowing through the rod and observe the direction of its displacement. It is now towards the right.
- Why does the rod get displaced?

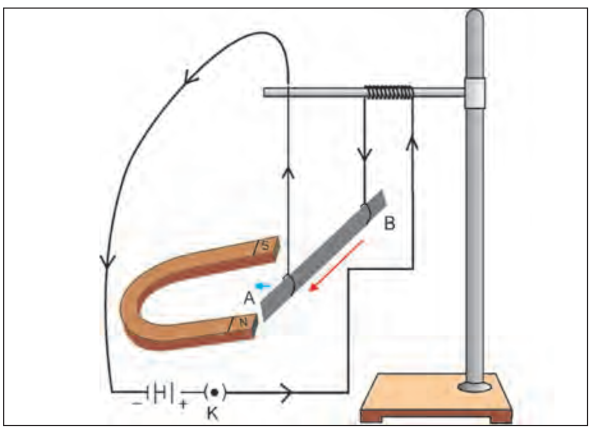


Fig. 17.8

The displacement of the rod in the above activity suggests that a force is exerted on the current- carrying aluminium rod when it is placed on a magnetic field. It also suggests that the direction of force is also reversed when the direction of current through the conductor is reversed. Now change the direction of field to vertically downwards by interchanging the two poles of the magnet. It is once again observed that the direction of force acting on the current-carrying rod gets reversed. It shows that the direction of force on the conductor depends upon the direction of current and the direction of magnetic field. Experiments have shown that the displacement of the rod is largest when the direction of current is at right angles to the direction of magnetic field.

17.3.1. Fleming left hand rule

We considered that the direction of the current and that of the magnetic field perpendicular to each other and found that the force is perpendicular to both of them. The three directions can be illustrated through a simple rule, called Fleming's left hand rule.(Fig.17.9).

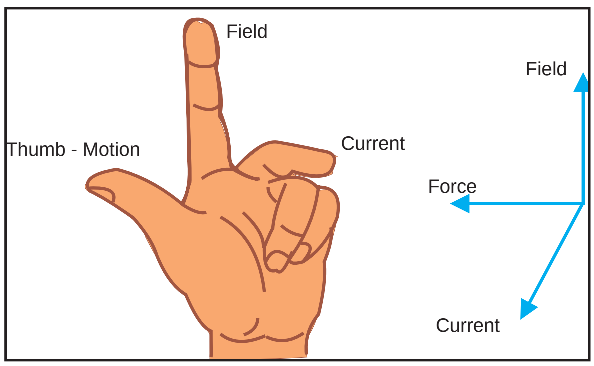


Fig. 17.9

Stretch the thumb, fore finger and middle finger of your left hand such

that they are mutually perpendicular. If the forefinger points in the direction of magnetic field and the middle finger points in the direction of current, then the thumb will point in the direction of motion or the force acting on the conductor.

17.4. ELECTRIC MOTOR

An electric motor is a rotating device that converts electrical energy in to mechanical energy. Do you know how an electric motor works?

An electric motor, as shown in Fig. 17.10, consists of a rectangular coil ABCD of insulated copper wire. The coil is placed between two poles of a magnetic field such that the arm AB and CD are perpendicular to the direction of magnetic field. The ends of the coil are connected to the two halves S_1 and S_2 of a split ring. The inner side of these halves insulated and attached to an axle. The external conducting edges of S_1 and S_2 touch two conducting stationary brushes B_1 and B_2, respectively.

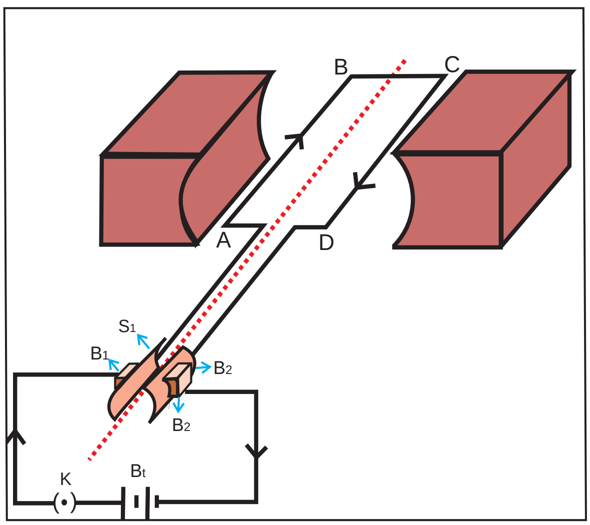


Fig. 17.9

Current in the coil ABCD enters from the source battery through conducting brush B_1 and flows back to the battery through brush B_2. Notice that the current in arm AB of the coil flows from A to B. In arm CD it flows from C to D, that is, opposite to the direction of current through arm AB. On applying Fleming's left hand rule for the direction of force on a current-carrying conductor in a magnetic field. We find that the force acting on arm AB pushes it downwards while the force acting on arm CD pushes it upwards. Thus the coil and the axle, mounted free to turn about an axis, rotate anti-clockwise. At half rotation S_2 makes contact with the brush B_1 and S_2 with brush B_2. Therefore the current in the coil gets reversed and flows along the path DCBA. A device that reverses the direction of flow of current through a circuit is called a commutator. In electric motors, the split ring acts as a commutator. The reversal of current also reverses the direction of force acting on the two arms AB and CD. Thus the arm AB of the coil that was earlier pushed down is now pushed up and the arm CD previously pushed up is now pushed down. Therefore the coil and the axle rotate half a turn more in the same direction. The reversing of the current is repeated at each half rotation, giving rise to a continuous rotation of the coil and to the axle.

The commercial motors use (i) an electro magnet in place of permanent magnet; (ii) large number of turns of the conducting wire in the current-carrying coil, and (iii) a soft iron core on which the coil is wound . The soft iron core, on which the coil is wound, plus the coils, is called an armature. This enhances the power of the motor.

17.5. ELECTROMAGNETIC INDUCTION

Faraday in1831 discovered that an electro motive force is produced in a circuit whenever the magnetic flux linked with a coil changes. He showed that emf is generated in a conductor when ever there is a relative motion between the conductor and a magnetic field. Then emf produced in this way is called an induced emf and the phenomenon is known as electro magnetic induction. The induced emf will cause a current to flow through the conductor. Such a current is known as induced current .Faraday made an important break through by discovering how a magnet can be used to generate electric currents.

17.5.1. Faraday's Experiments

We know that when a current-carrying conductor is placed in a magnetic field, it experiences a force. This force causes the conductor to move. Now let us imagine a situation in which a conductor is moving inside a magnetic field or a magnetic field is changing around a fixed conductor. What will happen? To observe this effect, let us perform the following activity.

ACTIVITY 17.7

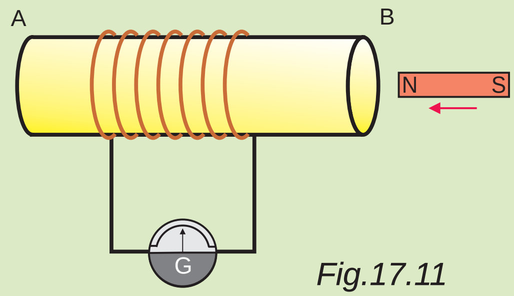


Fig.17.11

- Take a coil of wire AB having a large number of turns.
- Connect the ends of the coil to a galvanometer as shown in Fig.17.11
- Take a strong bar magnet and move its north pole towards the end B of the coil. Do you find any change in the galvanometer reading?
- There is a momentary deflection in the needle of the galvanometer, say to the right. This indicates the presence of a current in the coil AB. The deflection becomes zero, the moment the motion of the magnet stops.
- Now withdraw the north pole of the magnet away from the coil. Now the galvanometer is deflected toward the left, showing that the current is now setup in the direction opposite to the first.
- Place the magnet stationary at the point near to the coil, keeping its north pole toward the end B of the coil. We see that the galvanometer needle deflects towards the right when the coil is moved towards the north pole of the magnet. Similarly the needle moves toward left when the coil is moved away.
- When the coil is kept stationary with respect to the magnet, the deflection of the galvanometer drops to zero. What do you conclude from this activity?

You can also check that if you have moved South Pole of the magnet towards the end B of the coil, the deflections in the galvanometer would just be opposite to the previous case. When the coil and the magnet are both stationary, there is no deflection in the galvanometer. It is thus clear that motion of a magnet with respect to the coil produces an induced electromotive force, which sets up an induced electric current in the circuit.

Let us now perform a different activity in which the moving magnet is replaced by a current-carrying coil and the current in the coil can be varied.

ACTIVITY 17.8

- Two different coils of copper wire having large number of turns (say 50 and 100 turns respectively). Insert them over a non conducting cylindrical roll as shown in Fig.17.12.
- Connect the coil -1 having large number of turns, in series with a battery and a plug key. Also connect the other coil -2 with a galvanameter assam.
- ###Plug in the key. Observe the galvanameter. Is there a deflection in its needle?. You will observe that the needle of the galvanameter instantly jumps to one side and just as quickly returns to zero, indicating a momentary current in coil -2.
- Disconnect coil-1 from the battery. You will observe that the needle momentarily moves, but to the opposit side. It means that,

Now the current flows in the opposite direction in coil -2.

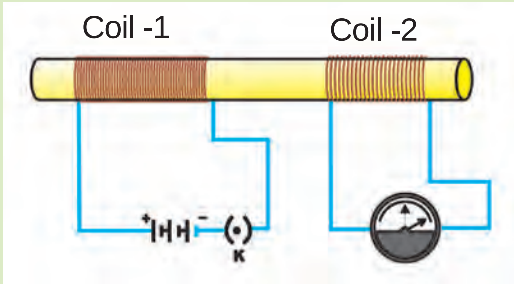


Fig. 17.12

In this activity we observe that as soon as the current in coil-1 reaches either a steady value or zero, the galvanometer in coil-2 shows no deflection. From these observations we conclude that a potential difference is induced in coil-2 when ever the current through the coil-1 is changing. Coil-1 is called the primary coil and coil-2 is called the secondary coil. As the current in the first coil changes, the magnetic field associated with it also changes. Thus the magnetic field lines around the secondary coil also change. Hence the change in magnetic field lines associated with the secondary coil is the cause of induced electric current in it. The direction of the induced current can be found using ***Fleming's right hand rule.***

Stretch the thumb, forefinger and middle finger of right hand so that they are perpendicular to each other. If the forefinger indicates the direction of the magnetic field and the thumb shows the direction of motion of conductor, then the middle finger will show the direction of induced current.

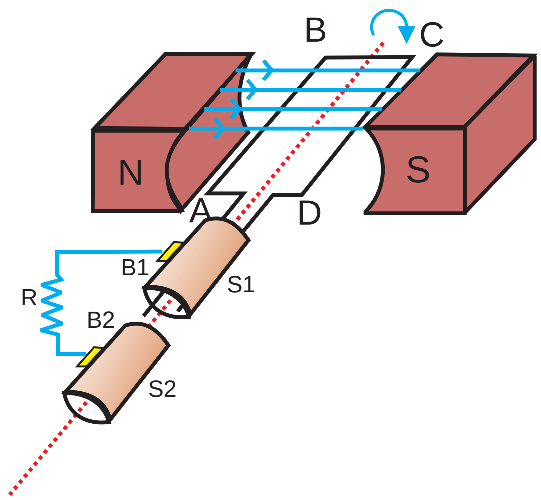
17.6. ELECTRIC GENERATOR

The phenomenon of electro magnetic induction is employed to produce large currents for use in homes and industry. In an electric generator, mechanical energy is used to rotate a conductor in a magnetic field to produce electricity.

An electric generator, as shown in Fig.17.13a, consists of rotating rectangular coil ABCD placed between the two poles of a permanent magnet. The two ends of this coil are connected to the two rings S_1 and S_2. The inner sides of these rings are made insulated. The two conducting stationary brushes B_1 and B_2 are kept pressed separately on the rings S_1 and S_2 respectively. The two rings S_1 and S_2 are internally attached to an axle. The axle may be mechanically rotated from outside to rotate the coil inside the magnetic field. Outer ends of the two brushes are connected to the external circuit.

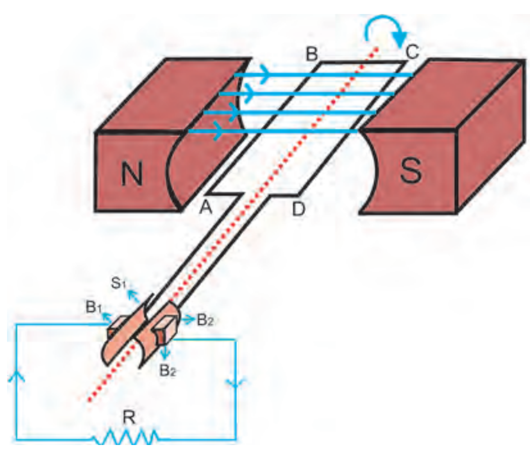
When the axle attached to the two rings is rotated such that the arm AB moves up, the arm CD moves down in the magnetic field produced by the permanent magnet. Let us say the coil ABCD is rotated clockwise. By applying Fleming's right-hand rule the induced currents are setup in these arms along the directions AB and CD. Thus an induced current flows in the direction ABCD. If there are large numbers of turns in the coil, the current generated in each turn adds up to give a large current through the coil. This means that the current in the external circuit flows from B_2 to B_1.

After half a rotation, arm CD starts moving up and AB moving down. As a result, the directions of the induced currents in both the arms change, giving rise to the net induced current in the direction DCBA. The current in the external circuit now flows from B_1 to B_2. Thus after every half rotation the polarity of the current in the respective arms changes. Such a current which changes direction after equal intervals of time, is called an alternating current (AC). This device is called an AC generator.



A.C Generator

a



D.C Generator

b

Fig 17.13

PHYSICS

To get a direct current (DC), a split-ring type commutator must be used with this arrangement, Fig.17.13b, one brush is at all times in contact with the arm moving up in the field, while the other is in contact with the arm moving down. Thus a unidirectional current is produced. The generator is thus called a DC generator.

An important advantage of AC over DC is that electric power can be transmitted over long distances without much loss of energy.

17.7. LIGHT

We see a variety of objects in the world around us. However we are unable to see anything in a dark room. On lighting up the room things becomes visible. What makes things visible? During the day the sunlight helps us to see objects. An object reflects light that falls on it. This reflected light when received by our eyes, enables us to see things.

There are a number of common wonderful phenomena associated with light. In this chapter, we shall study the phenomena of reflection and refraction of light using the straight-line propagation of light.

Reflection of light

A highly polished surface, such as a mirror, reflects most of the light falling on it. You are already familiar with the laws of reflection of light. Let us recall these laws.

(i) The angle of incidence is equal to the angle of reflection, and

(ii) The incident ray, the normal to the mirror at the point of incidence and the reflected ray, all lie in the same plane.

These laws of reflection are applicable to all types of reflecting surfaces including spherical surfaces.

Spherical mirrors

ACTIVITY 17.9

- Take a perfect hemispherical spoon. Try to view your face in its curved surface.
- Do you get the image? Is it larger or smaller?
- Move the spoon slowly away from your face. Observe the image. How does it change?
- Reverse the spoon and repeat the activity. How does the image look like now?
- Compare the characteristics of the images on the two surfaces.

The curved surface of a shining spoon could be considered as a curved mirror. The most commonly used type of curved mirror is the spherical mirror. The reflecting surface of a spherical mirror may be curved inwards or outwards. ***A spherical mirror whose reflecting surface is curved inwards is called a concave mirror. A spherical mirror whose reflecting surface is curved outwards is called a convex mirror.*** The schematic representation of these mirrors is shown in Fig. 17.14.

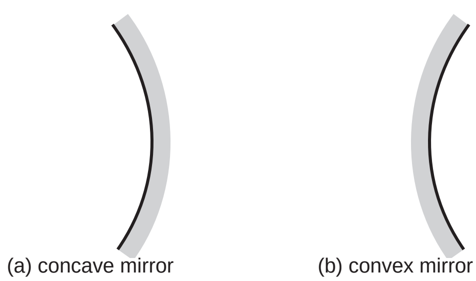


Fig 17.14

You may now understand that the surface of the spoon curved inwards can be approximated to a concave mirror and the surface of the spoon bulged outwards can be approximated to a convex mirror.

Before we move further on spherical mirrors, we need to recognise and understand the meaning of a few terms. These terms are commonly used in discussions about spherical mirrors.

The centre of the reflecting surface of a spherical mirror is a point, called the pole. It is represented by the letter P.

The reflecting surface of a spherical mirror forms a part of a sphere. This sphere has a centre. This point is called the centre of curvature of the spherical mirror. It is represented by the letter C.

The radius of the sphere of which the reflecting surface of a spherical mirror forms a part, is called the radius of curvature of the mirror. It is represented by the letter R.

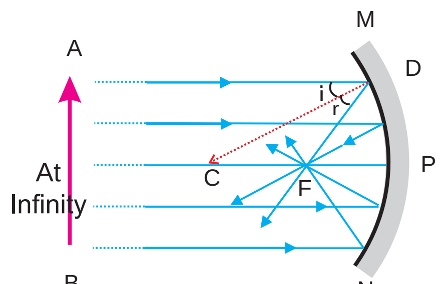
Imagine a straight line passing through the pole and the centre of curvature of a spherical mirror. This line is called the principle axis.

ACTIVITY 17.10

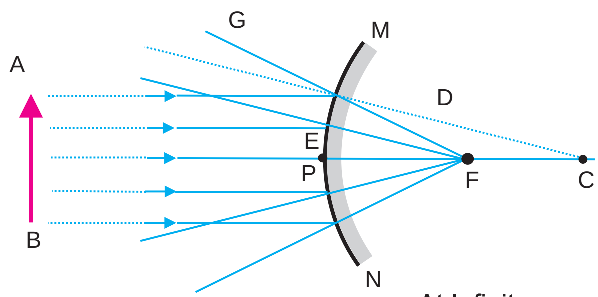
- Hold a concave mirror in your hand and direct its reflecting surface towards the sun.
- Direct the light reflected by the mirror on to a sheet of paper held close to the mirror.
- Move the sheet of paper back and forth gradually until you find on the paper sheet a bright, sharp spot of light.
- Hold the mirror and the paper in the same position for a few minutes. What do you observe? Why?

Let us understand important terms related to mirrors, through above activity.

The paper at first begins to burn producing smoke. It may even catch fire. Why does it burn? The light from the sun is converged at a point, as a sharp, bright spot by the mirror. In fact, this spot of light is the image of the sun on the sheet of paper. This point is the focus of the concave mirror. The heat produced due to the concentration of the sunlight ignites the paper. The distance of the image from the position of the mirror gives the approximate focal length of the mirror. Observe Fig.17.15(a) closely



(a)



(b)

Fig. 17.15

A number of rays parallel to the principal axis are falling on a concave mirror. Observe the reflected rays. They are all meeting at a point on the principal axis of the mirror. This point is called the principal focus of the concave mirror. Similarly

observe Fig. 17.15(b). How are the rays parallel to the principal axis reflected by a convex mirror? The reflected rays appear to come from a point on the principal axis. This point is called the principal focus of the convex mirror. The principal focus is represented by the letter F.

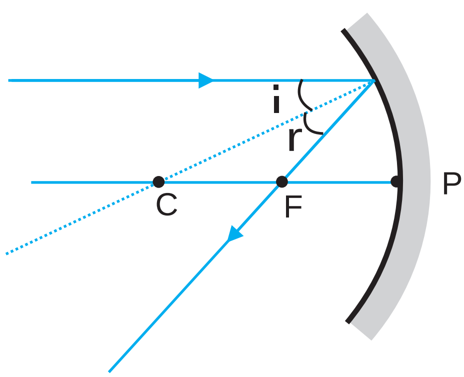
The distance between the pole and the principal focus of a spherical mirror is called the focal length. It is represented by the letter f.

The diameter of the reflecting surface of spherical mirror is called its aperture. In fig 17.15, distance MN represents the aperture. In our discussion we shall consider only such spherical mirrors whose aperture is much smaller than its radius of curvature.

Is there any relationship between the radius of curvature R, and focal length f, of a spherical mirror? For spherical mirrors of small apertures the radius of curvature is found to be equal to twice the focal length. We put this as **R = 2f.**

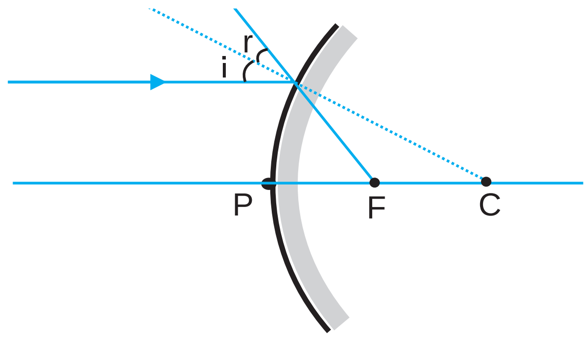
17.7.1 Reflection of light by spherical mirror

The reflection of light by a spherical mirror takes place according to certain definite rules as follows.



(a)

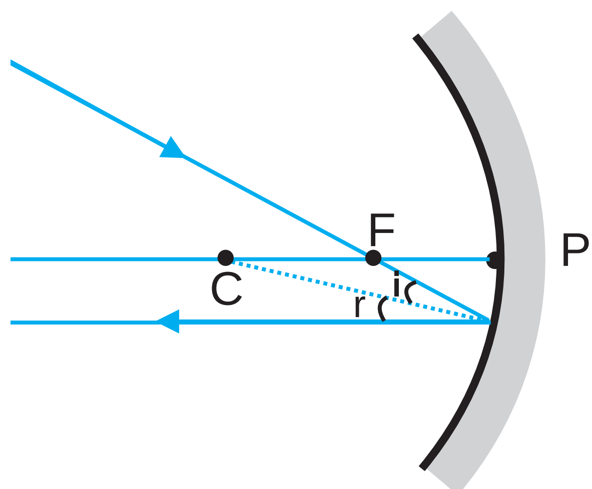
(i) A ray parallel to the principal axis, after reflection, will pass through principal focus in case of a concave mirror or appear to diverge from the principal focus in case of a convex mirror. This is illustrated in Fig. 17.16(a) and (b).



(b)

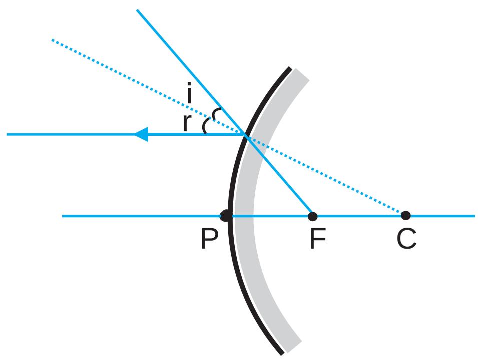
Fig. 17.16

(ii) A ray passing through the principal focus of a concave mirror or a ray directed towards the principal focus of a convex mirror, after reflection, will emerge parallel to the principal axis. This is illustrated in Fig.17.17 (a) and (b).



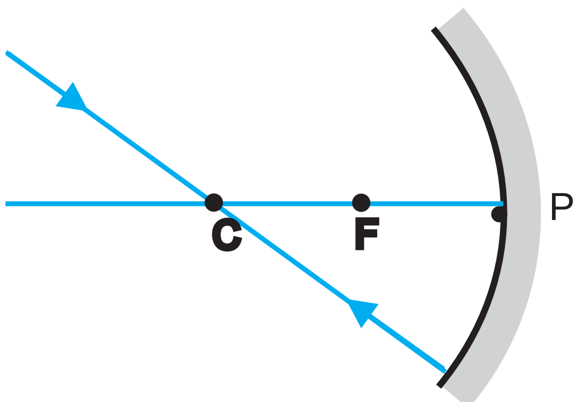
(a)

Fig. 17.17

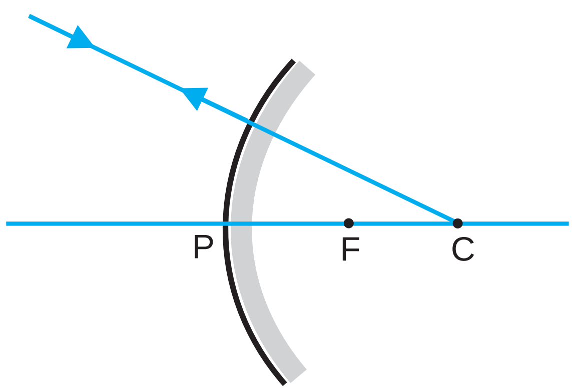


(b)

(iii) A ray passing through the centre of curvature of a concave mirror or directed in the direction of the centre of curvature of a convex mirror, after reflection, is reflected back along the same path. This is illustrated in Fig.17.18 (a) and (b).



(a)



(b)

Fig 17.18

Image formation by concave mirror

How about the images formed by spherical mirrors? How can we locate the image formed by a concave mirror for different positions of the object? Are the images real or virtual? Are the images enlarged, diminished or have the same size?

The nature, position and size of the image formed by a concave mirror depend on the position of the object in relation to point P, F and C. The image formed is real for some positions of the object. It is found to be a virtual image for a certain other position. The image is either magnified, reduced or has the same size, depending on the position of the object.

We can study the formation of image by spherical mirrors by drawing ray diagrams. To construct the ray diagrams, it is more convenient to consider only two rays. These rays are so chosen that it is easy to know their directions after reflection from the mirror. You may take any two of the rays mentioned in the previous section for locating the image. The intersections of the two reflected rays give the position of image of the point object. This is illustrated in the Fig.17.19.

Uses of concave mirror

Concave mirrors are commonly used in torches, search-lights and vehicles head lights to get powerful parallel beams of light. They are used as shaving mirrors to see a lager image of the face. The dentists use concave mirrors to see large images of the teeth of patients. Large concave mirrors are used to concentrate sun light to produce heat in solar furnaces.

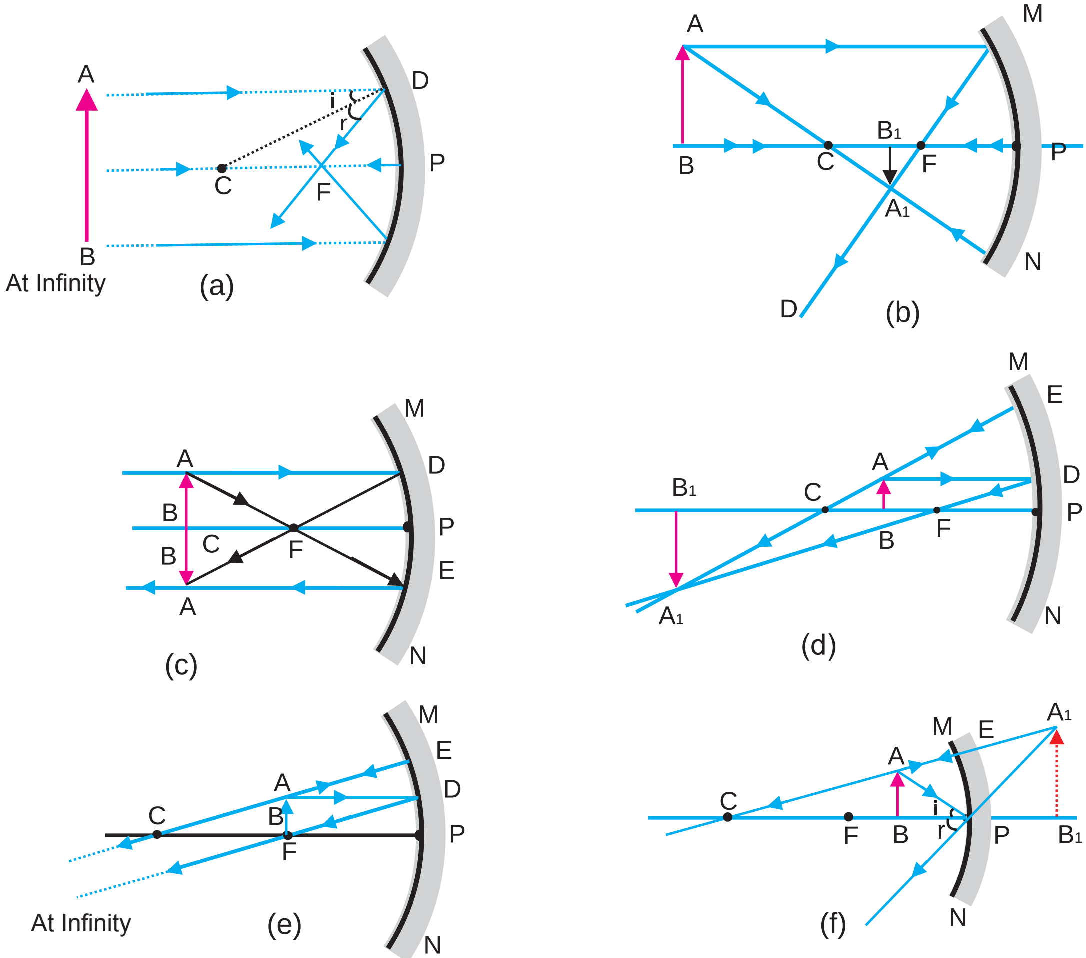


Fig 17.19

A summary of these observations is given in Table: 17.1.

Position of the Object	Position of the image	Relative size of the image	Nature of the image
At infinity	At focus F_2	Highly dimin-ished, point-sized	Real and inverted
Beyond $2F_1$	Between F_2 and $2F_2$	Diminished	Real and inverted
At $2F_1$	At $2F_2$	Same size	Real and inverted
Between F_1 & $2F_1$	Beyond $2F_2$	Enlarged	Real and inverted
At focus F_1	At infinity	Infinitely large or highly enlarged	Real and inverted
Between focus F_1 and optical centre O	On same side of the lens as the object	Enlarged	Virtual and erect

Table 17.1

Image formation by a convex mirror

We consider two positions of the object for studying the image formed by a convex mirror. First is when the object is at infinity and the second position is when the object is at a finite distance from the mirror. The ray diagrams for the formation of image by a convex mirror for these two positions of the object are shown in Fig 17.20(a) and (b), respectively.

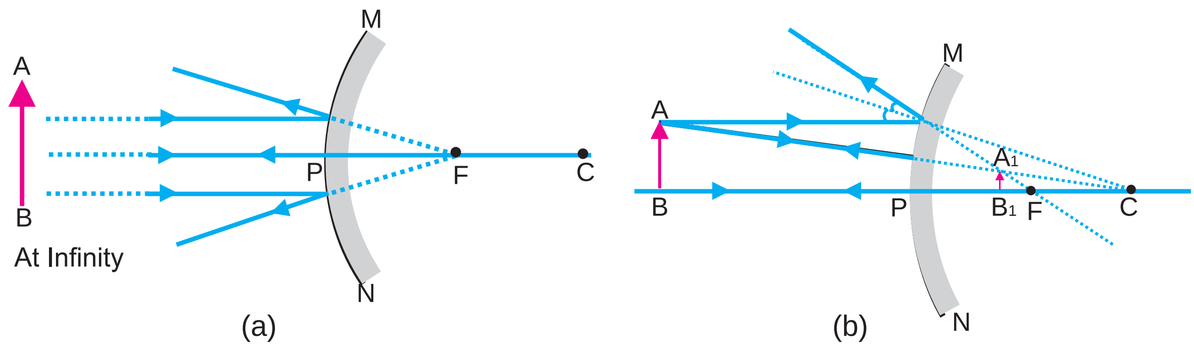


Fig. 17.20

A summary of these observations is given in Table: 17. 2

Position of the object	Position of the image	Relative size of the image	Nature of the image
At infinity	At focus F_1	Highly diminished, point-sized	Virtual and erect
Between infinity and optical centre O of the lens	Between focus F_1 and optical centre O	Diminished	Virtual and erect

Table 17.2

You have studied the image formation by a concave mirror and a convex mirror, which of these mirrors will give the full image of a large object? Let us explore through an activity.

ACTIVITY 17.11

- Observe the image of a distant tree in a concave mirror.
- Could you see a full length image?
- Repeat this Activity with a convex mirror. Did the mirror show full length image of the object?
- Explain your observations with reason.

You can see a full length image of a tree in a small convex mirror.

Uses of convex mirrors

Convex mirrors are commonly used as rear-view mirrors in vehicles. These mirrors are fitted on the sides of the vehicle, enabling the driver to see traffic behind him/her to facilitate safe driving. Convex mirrors are preferred because they always give an erect image. Also they have a wider field of view as they are curved outwards.

Sign convention for reflection by spherical mirrors

While dealing with the reflection of light by spherical mirrors, we shall follow a set of sign conventions called the ***New Cartesian Sign Convention***. In this convention, the pole (P) of the mirror is taken as the origin. The principal axis of the mirror is taken as the X axis (X′X) of the coordinate system. The conventions are as follows.

(i) The object is always placed to the left of the mirror.

(ii) All distances parallel to the principal axis are measured from the pole of the mirror.

(iii) All the distances measured to the right of the origin (along +X-axis) are taken as positive while those measured to the left of the origin (along -X-axis) are taken as negative

(iv) Distances measured perpendicular to and above the principal axis (along +Y-axis) are taken as positive.

(v) Distances measured perpendicular to and below the principal axis (along -Y-axis) are taken as negative.

The New Cartesian Sign Convention described above is illustrated in Fig. 17.21.

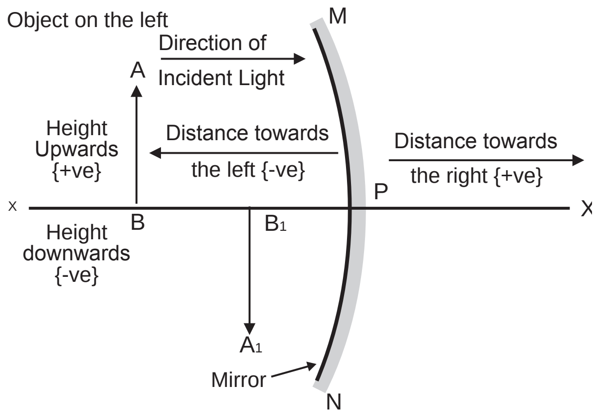


Fig. 17.21

These sign conventions are applied to obtain the mirror formula

Mirror formula

In a spherical mirror, the distance of the object from its pole is called the object distance (u). The distance of the image from the pole of the mirror is called the image distance (v). You already know that the distance of the principal focus from the pole is called the focal length (f). There is a relationship between these three quantities given by the mirror formula which is expressed as

$$\mathbf{1/\mathit{v} + 1/\mathit{u} = 1/\mathit{f}}$$

This formula is valid in all situations for all spherical mirrors for all positions of the object. You must use the New Cartesian Sign convention while substituting numerical values for u, v, f, and R in the mirror formula for solving problems.

Example: 17.1

A convex mirror used for rear-view on an automobile has a radius of curvature of 3 m. If a bus is located at 5 m from this

mirror, find the position and nature of the image.

Solution:

Radius of curvature, R = +3.00 m

Object distance u = - 5.00 m

Image distance v = ?

Focal length ,

f = R/2 = + 3.00 m/2 = 1.5 m

We know,

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

or,

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$

$$= \frac{1}{1.5} - \frac{1}{-5.00} = \frac{1}{1.5} + \frac{1}{5.00}$$

$$= \frac{5.00 + 1.50}{7.50} = \frac{6.50}{7.50}$$

$$V = \frac{7.50}{6.50} = 1.15 \text{ m}$$

The image is 1.15 m at the back of the mirror. The image is virtual.

17.7.2. Refraction of light

Light seems to travel along straight-line paths in a transparent medium. What happens when light enters from one transparent medium to another? Does it still move along a straight-line path or change its direction? We shall recall some of our day-to-day experiences.

You might have observed that the bottom of a tank or a pond containing water appears to be raised. Similarly, when a thick glass slab is placed over some printed matter, the letters appear raised when viewed through the glass slab. Why does it happen? Have you seen a pencil partially immersed in water in a glass tumbler? It appears to be displaced at the interface of air and water. You might have observed that a lemon kept in water in a glass tumbler appears to be bigger than its actual size, when viewed from the sides. How can you account such experiences?

Let us consider the case of the apparent displacement of the pencil, partly immersed in water. The light reaching you from the portion of the pencil inside water seems to come from a different direction, compared to the part above water. This makes the pencil appear to be displaced at the interface. For similar reasons, the letters appear to be raised, when seen through a glass slab placed over it.

Does a pencil appear to be displaced to the same extent, if instead of water, we use liquids like kerosene or turpentine? Will the letters appear to rise to the same height if we replace a glass slab with a transparent plastic slab? You will find that the extent of the effect is different for different pair of media. These observations indicate that light does not travel in the same direction in all media. It appears that when traveling obliquely from one medium to another, the direction of propagation of light in the second medium changes. This phenomenon is known as refraction of light. Let us understand this phenomenon further by doing an activity.

ACTIVITY 17.12

- Place a coin at the bottom of a bucket filled with water.
- With your eye to a side above water, try to pick up the coin in one go. Did you succeed in picking up the coin?
- Repeat the Activity. Why did you not succeed in doing it in one go?
- Ask your friends to do this. Compare your experience with theirs.

The apparent position of the coin as seen through water differ from its actual position .

Laws of refraction

Refraction of light is due to change in the speed of light as it enters from one transparent medium to another. Experiments show that refraction of light occurs according to certain laws. The following are the laws of refraction of light.

(i) ***The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.***

(ii) ***The ratio of sine of angle of incidence to the sine of angle of refraction is a constant, for the light of a given colour and for the given pair of media. This law is also known as Snell's law of refraction.***

If ***i*** is the angle of incidence and ***r*** is the angle of refraction, then,

Sin *i* /sin *r* = *constant*

This constant value is called the refractive index of the second medium with respect to the first.

17.7.3 Refractive index

We know that a ray of light travels obliquely from one transparent medium into another will change its direction in the second medium. The extent of the change in direction that takes place in a given pair of media is expressed in terms of the refractive index of the second medium with respect to the first medium.

The refractive index can be linked to the relative speed of propagation of light in different media. Light propagates with different speeds in different media. It travels the fastest in vacuum with the highest speed of $\mathbf{3 \times 10^8\ m\ s^{-1}}$. Its speed reduces considerably in glass.

Consider a ray of light traveling from medium 1 into medium 2 as in Fig.17.22. Let i,r be the angle of incidence and angle of refraction.

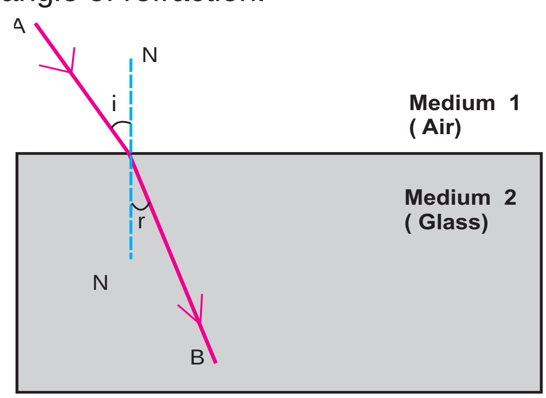


Fig. 17.22

The refractive index of the second medium with respect to the first

μ = Sin ***i*** /sin ***r***

$$\mu = \frac{\text{Speed of light in air}}{\text{Speed of light in medium}}$$

17.7.4 Refraction by spherical lenses

Spherical lenses

You might have seen people using spectacles for reading. The watchmakers use a small magnifying glass to see tiny parts. Have you ever touched the surface of a magnifying glass with your hand? Is it plane surface or curved? Is it thicker in the middle or at the edges? The glasses used in spectacles and that by watchmaker are examples of lenses. What is a lens? How does it bend light rays? Let us discuss in this section.

A transparent material bound by two surfaces, of which one or both surfaces are spherical, forms a lens. This means that a lens is bound by at least one spherical surface. In such spherical lenses, the other surface would be plane. A lens may have two spherical surfaces, bulging outwards. Such a lens is called a double convex lens. It is simply called a convex lens. It is thicker at the middle as compared to the edges. Convex lens converges light rays. Hence it is called converging lens. Similarly, a double concave lens is bounded by two spherical surfaces, curved inwards. It is thicker at the edges than at the middle. Such lenses diverge light rays and are called diverging lenses. A double concave lens is simply called a concave lens.

Let us understand the meaning of a few terms which are commonly used in discussions about spherical lenses. A lens has two spherical surfaces. Each of these surfaces forms a part of a sphere. The centers of these spheres are called ***centres of curvature of the lens***. The centre of curvature of a lens is usually represented by the letter C. Since there are two centre's of curvature, we may represent them as C_1 and C_2.

An imaginary straight line passing through the two centres of the curvature of a lens is called its ***principal axis.***

The central point of a lens is called its ***optical centre***. It is represented by the letter O. A ray of light through the optical centre of a lens passes without suffering any deviation.

The effective diameter of the circular outline of a spherical lens is called its ***aperture***. Lenses whose aperture is much less than its radius of curvature are called thin lenses with small aperture. What happens when parallel rays of light are incident on a lens?

ACTIVITY 17.13

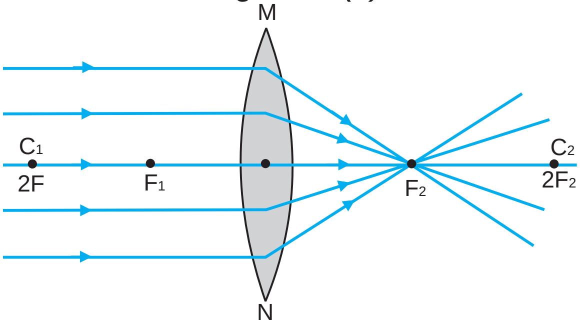
- CAUTION: Do not look at the sun directly or through a lens while doing this Activity or otherwise. You may damage your eyes if you do so.
- Hold a convex lens in your hand. Direct it towards the sun.
- Focus the light from the sun on a sheet of paper. Obtain a sharp bright image of the sun.
- Hold the paper and the lens in the same position for a while. Keep observing the paper. What happened? Why?

The light from the sun constitutes parallel rays. These rays were converged by the lens as a sharp bright spot. This is the real image of the sun. The

concentration of the sun light at this spot generated heat. This caused the paper to burn.

Observe Fig.17.23(a) carefully.

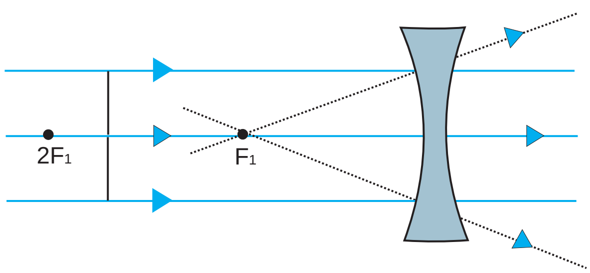
Fig.17.23(a)



Several rays of light parallel to the principal axis are falling on a convex lens. These rays after refraction from the lens are converging to a point on the principal axis. This point is called the ***principal focus*** of the lens.

Observe Fig. 17.23(b) carefully,

Fig.17.23(b)



Several rays of light parallel to the principal axis are falling on a concave lens. These rays after refraction from the lens, are appearing to diverge from a point on the principal axis. This point is called the ***principal focus*** of the concave lens.

If you pass parallel rays from the opposite surface of the lens, you will get another principal focus on the opposite side. Letter F is usually used to represent principal focus. However, a lens has two principal foci. They are represented by F_1 and F_2.

The distance of the principal focus from the optical centre of a lens is called its ***focal length***. The letter ***f*** *is* used to represent the focal length.

17.7.5 Image formation by lenses

We can represent image formation by lenses using ray diagrams. Ray diagrams will also help us to study the nature, position and relative size of the image formed by the lenses. For drawing ray diagrams in lenses, we consider any two of the following rays.

(i) A ray of light from the object, parallel to the principal axis, after refraction from a convex lens, passes through the principal focus on the other side of the lens, as shown in Fig.17.24(a). In case of a concave lens, the ray appears to diverge from the principal focus located on the same side of the lens, as shown in Fig.17.24(b)

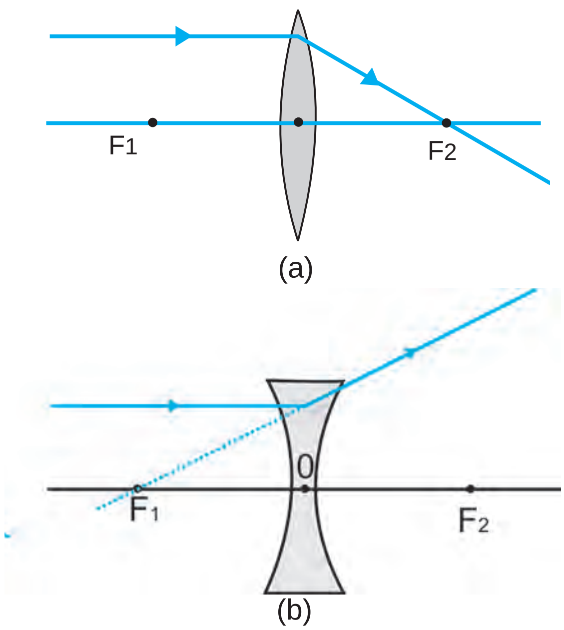


Fig. 17.24

(ii) A ray of light passing through a principal focus after refraction from a convex lens will emerge parallel to the principal axis. This is shown in Fig 17.25(a). A ray of light appearing to meet at the principal focus of a concave lens, after refraction, will emerge parallel to the principal axis. This is shown in Fig. 17.25(b).

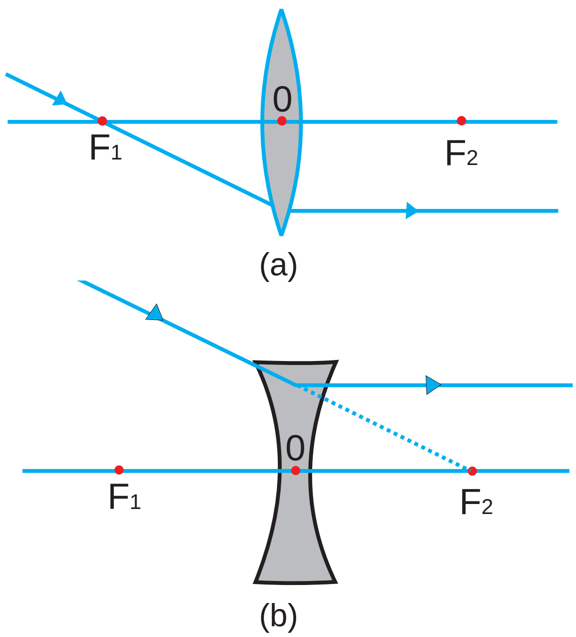


Fig. 17.25

(iii) A ray of light passing through the optical centre of a lens will emerge without any deviation. This is illustrated in Fig 17.26(a) and (b).

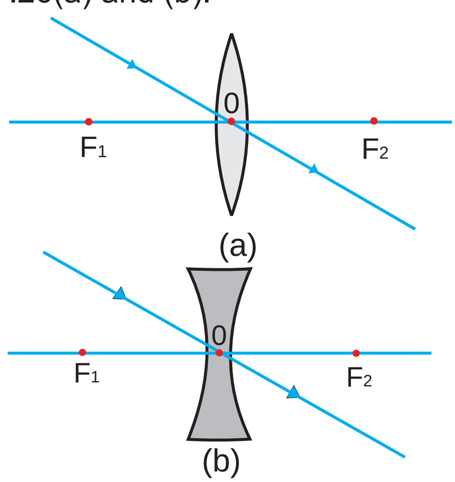


Fig. 17.26

Sign convention for spherical lenses:

All measurements are taken from the optical centre of the lens. According to the convention, the focal length of a convex lens is positive and that of a concave lens is negative. We must take care to apply appropriate signs for the values of *u, v, f,* object height *h* and image height *h'.*

17.7.6 Lens formula

This formula gives the relation between object-distance (*u*), image-distance (v) and the focal length (*f*). The lens formula is expressed as

$$\frac{1}{v} + \frac{1}{u} = -\frac{1}{f}$$

The lens formula given above is general and is valid in all situations for any spherical lenses.

Example: 17.2

A concave lens has focal length of 15 cm. At what distance should the object from the lens be placed so that it forms an image 10 cm from the lens?

Solution:

v = -10 cm, f = - 15 cm, u = ?

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ Or,

$$\frac{1}{u} = \frac{1}{v} - \frac{1}{f}$$

$$\frac{1}{u} = \frac{1}{-10} - \frac{1}{-15}$$

$$\frac{1}{u} = \frac{-3+2}{30} = \frac{-1}{30}$$

u = -30 cm

Thus, the object distance is 30 cm.

The ray diagrams for the image formation in a convex lens for a few positions of the object are shown in Fig. 17.27.

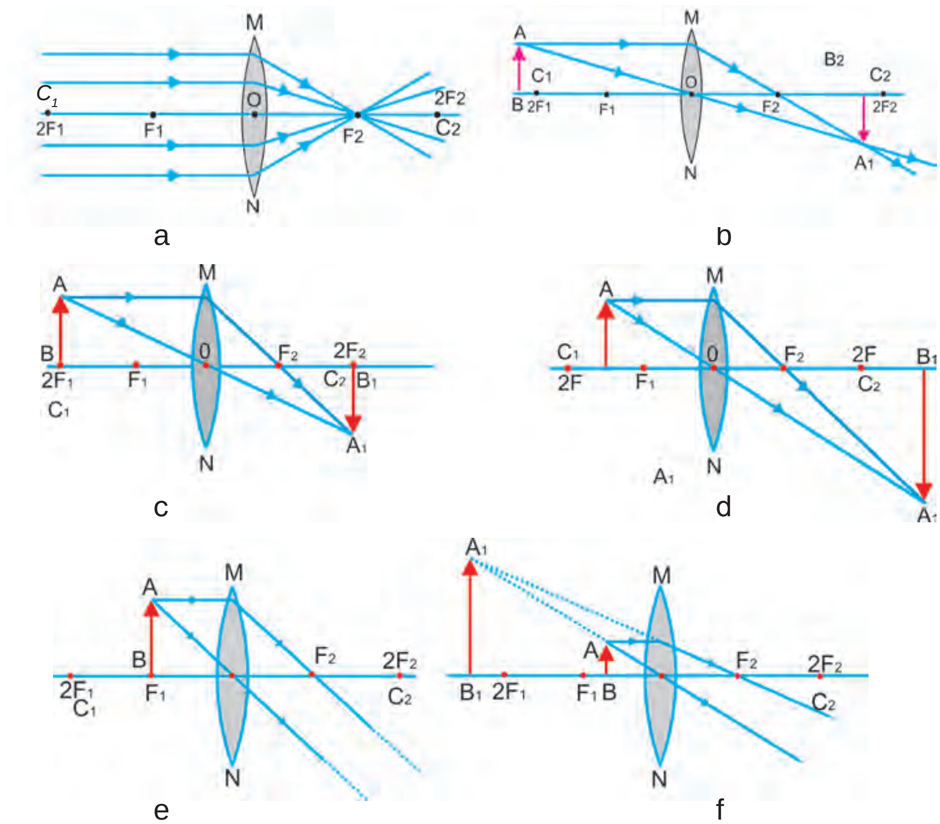


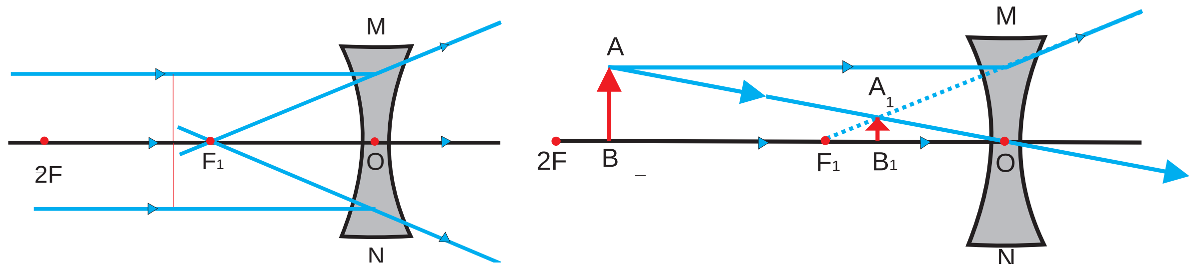
Fig. 17.27

A summary of these observations is given in Table 17.3.

Positionon of the object	**Position of the image**	**Relative size of the image**	**Nature of the image**
At infinity	At focus F	Highly dimin-ished, point-sized	Real and inverted
Beyond 2F	Between F and 2F	Diminished	Real and inverted
At 2F	At 2F	Same size	Real and inverted
Between F and 2F	Beyond 2F	Enlarged	Real and inverted
At focus F	At infinity	Infinitely large or highly enlarged	Real and inverted
Between focus F and optical centre O	On the Same side of the lens as the object	Enlarged	Virtual and erect

Table 17.3

The ray diagrams for the image formation in a concave lens for various positions of the object are shown in Fig. 17.28.



(a) (b)

Fig. 17.28

A summary of these observations is given in Table. 17.4.

Position of the objecob-ject	Position of the image	Relative size of the image	Nature of the image
At infinity	At focus F	Highly diminished, point-sized	Virtual and erect
Between infin-ity and optical center O of the lens	Between focus F and optical center O	Diminished	Virtual and erect

Table 17.4

Magnification

The magnification produced by a lens is defied as the ratio of the height of the image to the height of the object

It is represented by the letter m. If h is the height of the object and h' is the height of the image given by the lens, then the magnification produced by the lens is given by,

$$m = \frac{\text{Height of the image } (h')}{\text{Height of the object } (h)} = \frac{v}{u}$$

Example: 17.3

An object is placed at a distance of 30 cm from a concave lens of focal length 15 cm. An erect and virtual image is formed at a distance of 10 cm from the lens. Calculate the magnification.

Solution:

Object distance, u = -30 cm

Image distance, v = -10 cm

Magnification, m = v/u

$$m = \frac{-10 \text{ cm}}{-30 \text{ cm}} = \frac{1}{3} = \mathbf{+\ 0.33}$$

17.7.7. Power of lens

The degree of convergence or divergence of light rays achieved by a lens is expressed in terms of its power. ***The power of a lens is defined as the reciprocal of its focal length***. It is represented by the letter *P*. The power *P* of a lens of focal length *f* is given by

$$P = \frac{1}{f}$$

The SI unit of power of a lens is ***'dioptre'***. It is denoted by the letter D. If f *is* expressed in meter, then, power is expressed in dioptres. Thus 1 dioptre is the power of a lens whose focal length is 1 meter. The power of a convex lens is positive and that of a concave lens is negative.

Example: 17.4

The focal length of a concave lens is 2m. Calculate the power of the lens.

Solution:

Focal length of concave lens, f = - 2 m
Power of the lens,

$$p = \frac{1}{f}$$

$$p = \frac{1}{-2m}$$

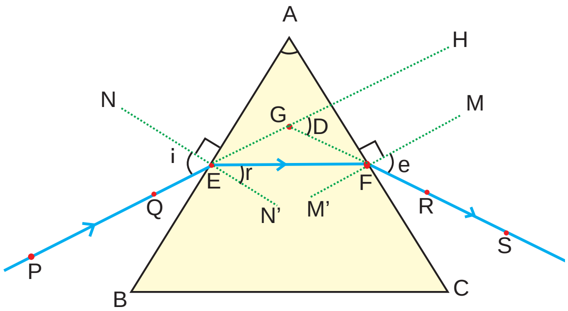
p = - 0.5 dioptre

17.7.8. Refraction of light through a prism

Consider a triangular glass prism. It has two triangular bases and three rectangular lateral surfaces. These surfaces are inclined to each other. The angle between its lateral faces is called the angle of the prism. Let us now do an activity to study the refraction of light through a triangular glass prism.

ACTIVITY 17.14

- Fix a sheet of white paper on a drawing board using drawing pins.
- Place a glass prism on it in such a way that it rests on its triangular base. Trace the out line of the prism using a pencil.
- Draw a straight line PE inclined to one of the refracting surfaces, say AB, of the prism.
- Fix two pins, say at points P and Q, on the line PE as shown in Fig 17.29
- Look for the images of the pins, fixed at P and Q, through the other face AC.
- Fix two more pins, at points R and S, such that the pins at R and S lie on the same straight line.
- Remove the pins and the glass prism.
- The line PE meets the boundary of the prism at point E (see Fig 17.29). Similarly, join and produce the points R and S. Let these lines meet the boundary of the prism at E and F, respectively. Join E and F.
- Draw perpendicular to the refracting surfaces AB and AC of the prism at points E and F, respectively.
- Mark the angle of incidence (∠i), the angle of refraction (∠r) and the angle of emergence (∠e) as shown in Fig 17.29.



PE - Incident ray

EF - Refracted ray

FS - Emergent ray

∠A - Angle of the Prism

∠i - Angle of incident

∠r - Angle of refraction

∠e - Angle of emergence

∠D - Angle of deviation

Fig.17.29

Here PE is the incident ray. EF is the refracted ray. FS is the emergent ray. You may note that a ray of light is entering from air to glass at the first surface AB. The light ray on refraction has bent towards the normal. At the second surface AC, the light ray has entered from glass to air. Hence it has bent away from normal. Compare the angle of incidence and angle of refraction at each refracting surface of the prism. The peculiar shape of prism makes the emergent ray bent at an angle to the direction of the incident ray. This angle ∠r is called the angle of refraction. In this case ∠D is the angle of deviation. Mark the angle of deviation in the above activity and measure it.

17.7.9. Dispersion of white light by a glass prism

You must have seen and appreciated the spectacular colours in a rainbow. How could the white light of the sun give us various colours of the rainbow?

The prism has probably split the incident white light into a band of colours. Note the colours that appear at the two ends of the colour band. What is the sequence of colours that you see on the screen? The various colours seen are Violet, Indigo, Blue, Green, Yellow, Orange and Red. As shown in Fig.17.30.

ACTIVITY 17.15

- Take a thick sheet of cardboard and make a small hole in its middle.
- Allow sunlight to fall on the narrow slit. This gives a narrow beam of white light.
- Now, take a glass prism and allow the light from the slit to fall on one of its faces.
- Turn the prism slowly until the light that comes out of it appear on a near by screen.
- What do you observe? You will find a beautiful band of colours.
- Why does this happen?

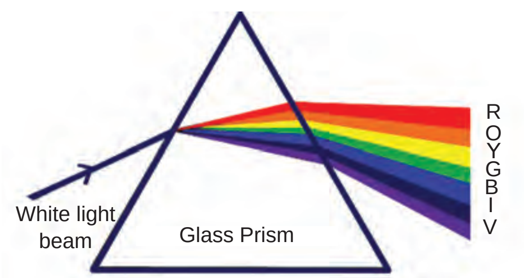


Fig. 17.30

The acronym **VIBGYOR** will help you to remember the sequence of colours.

The band of the coloured component of a light beam is called its spectrum. You might not be able to see all the colours separately. Yet something makes each colour distinct from the other. The splitting of light into its component colours is called dispersion.

You have seen that white light is dispersed into its seven-colour components by a prism. Why do we get these colours? Different colours of light bend through different angles with respect to the incident ray as they pass through the prism. The red light bends the least while the violet the most. Thus the rays of each colour emerge along different paths and thus become distinct. It is the band of distinct colours that we see in a spectrum.

17.7.10. Atmospheric refraction

You might have observed the apparent random wavering or flickering of objects seen through a turbulent stream of hot air rising above a fire. The air just above the fire becomes hotter than the air further up. The hotter air is lighter (less dense) than the cooler air above it, and has a refractive index slightly less than that of the cooler air. Since the physical conditions of the refracting medium (air) are not stationary, the apparent position of the object, as seen through the hot air fluctuates. This wavering is thus an effect of atmospheric refraction (refraction of light by the earth's atmosphere) on a small scale in our local environment. The twinkling of stars is a similar phenomenon on a much larger scale.

17.7.11. Human eye

The human eye is one of the most valuable and sensitive sense organs. It enables us to see the wonderful worlds and colours around us. Of all our sense organs, the human eye is the most significant one as it enables us to see the beautiful, colorful world around us.

The human eye is like a camera. Its lens system forms an image on a light-sensitive screen called the ***retina***. Light enters the eye through the thin membrane called the ***cornea***. It forms the transparent bulge on the front surface of the eye ball as shown in Fig. 17.31.

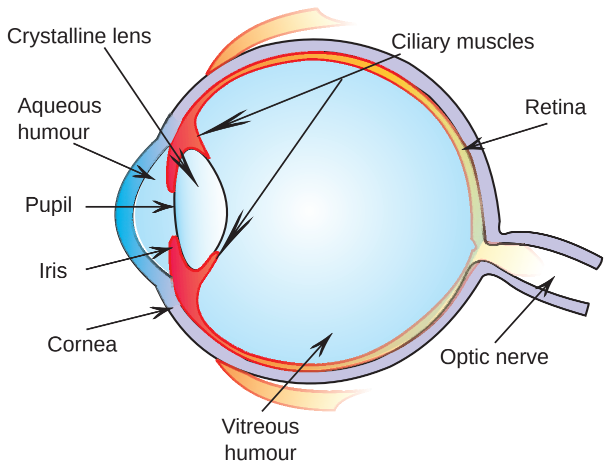


Fig 17.31

The eye ball is approximately spherical in shape with a diameter of about 2.3cm. Most of the refraction for the light rays entering the eye occurs at the outer surface of the cornea. The crystalline lens merely provides the finer adjustment of focal length required to focus objects at different distances on the ***retina***. We find a structure called ***iris*** behind the cornea. Iris is a dark muscular diaphragm that controls the ***pupil.*** The pupil regulates and controls the amount of light entering the eye. The eye lens forms an inverted real image of the object on the retina. The retina is a delicate membrane having enormous number of ***light-sensitive cells***. The light sensitive cells get activated upon illumination and generate ***electrical signals***. These signals are sent to the brain via the ***optic nerves.*** The brain interprets these signals, and finally, processes the information so that we perceive objects as they are.

Defects of vision and rectification

There are mainly three common refractive defects of vision. These are (i) ***Myopia*** or near - sightedness.(ii) ***Hypermetropia*** or far-sightedness, and (iii) ***Presbyopia*.** These defects can be corrected by the use of suitable spherical lenses.

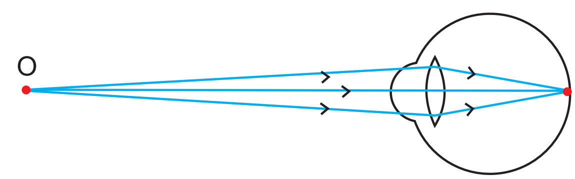
(a) Myopia

Myopia is also known as near-sightedness. A person with myopia can see near by objects clearly but cannot see the distant objects distinctly. A person with this defect has the far point nearer than infinity. Such a person may see clearly up to a distance of a few meters. In a myopic eye, the image of a distant object is formed in front of the retina [Fig. 17.32(a)] and not at the retina itself.

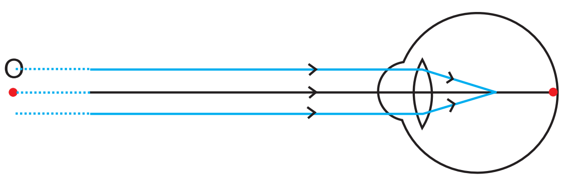
This defect may arise due to (i) excessive curvature of the eye lens, or (ii) elongation of the eyeball. This defect can be corrected by using a concave lens of suitable power. This is illustrated in Fig.17.32(c). A concave lens of suitable power will bring the image back on to the retina and thus the defect is corrected.

(b) Hypermetropia

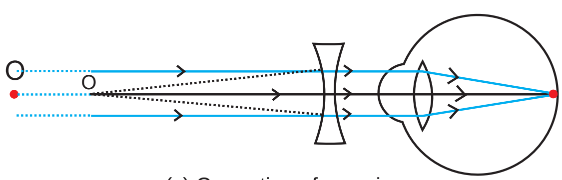
Hypermetropia is also known as far-sightedness. A person with hypermetropia can see distant objects clearly but cannot see near by objects distinctly. The near point, for the person, is further away from the normal near point (25 cm). Such a person has to keep a reading material such beyond 25cm from the eye for comfortable reading. This is because the light rays from a close by object are focused at a point behind the retina as shown in Fig.17.33 (b)



(a) Far point of myopia eye

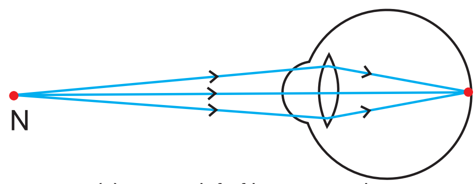


(b) myopia eye

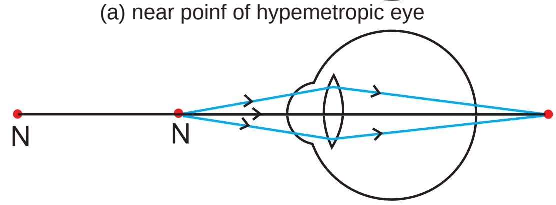


(c) Correction of myopia

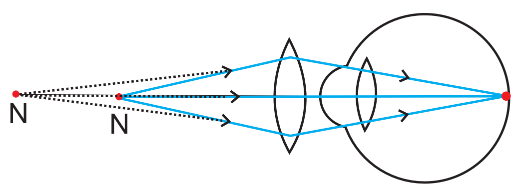
Fig. 17.32



(a) near poinf of hypemetropic eye



(b) Hypemetropia eye



(c) correction of hypemetropia eye

Fig. 17.33

This defect either because (i) the focal length of the eye lens is too long or (ii) the eyeball has become too small. This defect can be corrected by using a convex lens of appropriate power. This is illustrated in Fig.17.33(c). Eye- glasses with converging lenses provide the additional focusing power required for forming the image on the retina.

(c) Presbyopia

The power of accommodation of the eye usually decreases with ageing. For most people, the near point gradually recedes away. They find it difficult to see near by objects comfortably and distinctly without corrective eye - glasses. This defect is called ***Presbyopia***. It arises due to the gradual weakening of the ***ciliary muscles*** and diminishing flexibility of the eye lens. Sometimes, a person may suffer from both myopia and hypermetropia. Such people often require by-focal lenses. A common type of by-focal lenses consists of both concave and convex lenses. The upper portion consists of a concave lens. It facilitates near vision. These days, it is possible to correct the refractive defects with contact lenses.

17.12. Science today - Hubble space telescope (H.S.T)

Hubble telescope is a space telescope that was carried into orbit by a space shuttle in April 1990. It is named after the American astronomer Edwin Hubble. It becomes a most popular research tool for astronomy. The H.S.T is collaboration between NASA and the European Space Agency, and is one of NASA's great observatories.

Hubble is the only telescope ever designed to be serviced in space by astronauts. The H.S.T design with two hyperbolic mirrors is known for good imaging performance over a wide field of view. During the launch scientist found that the main mirror had been ground incorrectly, which severely affect the telescopes capabilities. After a servicing mission in 1993, the telescope was restored to its intended quality. Four servicing missions where performed from 1993-2002. But the fifth was completed in 2009. The telescope is now expected to function until at least 2014.

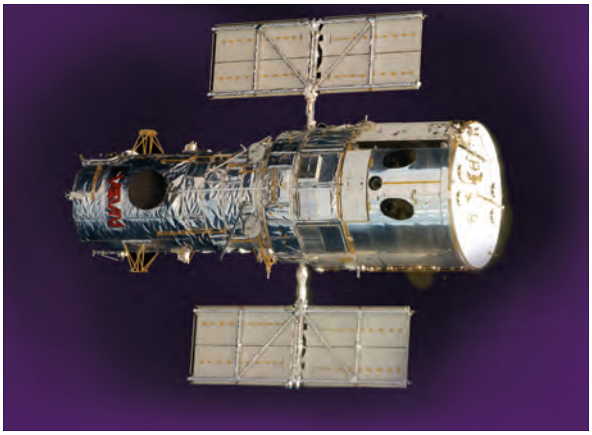


Fig.17.34

Hubble's orbit outside the distortion of earth's atmosphere allows it to take extremely sharp images with almost no background light. Hubble's Ultra Deep Field image is the most detailed visible-light image ever made of the universe's most distant object. Hubble Deep field and Hubble ultra Deep field images reveals that galaxies are billions of light years away.

Many Hubble observations accurately measure the rate at which the universe is expanding. It constrain the value of

Hubble's constant and estimates the age of the Universe.

Hubble's images of planets were crucial in studying the dynamics of the collision of a comet with Jupiter, an event believed to occur once every few centuries.

Hubble's observations found that black holes are common to the centers of all galaxies.

The astronomers used the telescope to observe distant supernovae.

EVALUATION

PART A

1. The magnification produced by a mirror is 1/3, then the type of mirror is

   (concave, convex, plane)

2. An electric current through a metallic conductor produces __________ around it.

   (heat, light, magnetic field, mechanical force)

3. The field of view is maximum for (plane mirror, concave mirror, convex mirror)

4. An object is placed 25 cm from a convex lens whose focal length is 10 cm. The image distance is _________ .(50 cm, 16.66 cm, 6.66 cm, 10 cm)

PART B

1. From the following statement write down that which is applicable to a commutator.

   a) galvanometer uses commutator for deadbeat

   b) transformer uses commutator to step up voltage

   c) mototr uses commutator to reverse the current

2. Fill in the blanks

   a) For a motor : a permanent magnet, then commercial motor : ________

   b) Focal length of a lens; meter, then for power of a lens_____________

3. Correct the mistakes, if any, in the following statements.

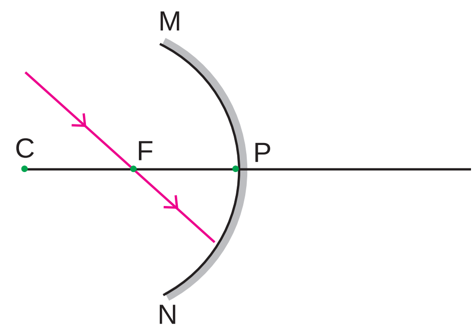
   a) Magnetic field is a quantity that has magnitude only.

   b) The magnetic field lines emerge from the south pole and merge at the north pole.

4. The ray diagram shown below is introduced to show how a concave mirror forms an immage of an object.

   a) identify the mistake and draw the correct ray diagram.

   b) Write the justifications for your corrections.



5. In traffic signals __________ colour light is used to stop vechicles because it is having ______ wave length.

6. Considering this write down the names of the parts in human eye.

   a) Dark muscular diaphragm that controls the pupil.

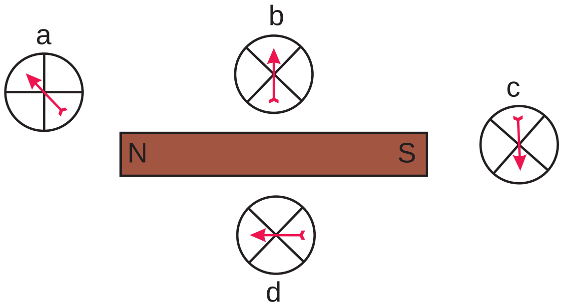
   b) The screen at where the image is formed by eye lens.

7. You know that myopia is a common refractive defects of vision. Person with this defect can see only nearby objects clearly. Using concave lens of suitable power this defect is corrected.

   a) mention other two types of defects like this.

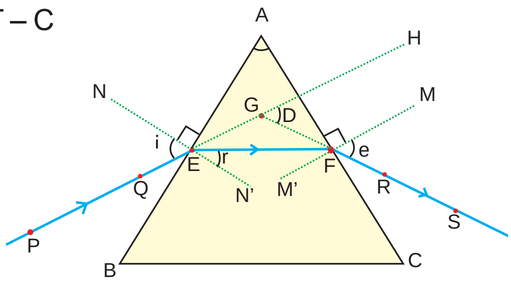
b) explain how can we correct it.

8. (a) Which of the compass needle orientations in the following diagram might correctly describe the magnet's field at that point?



(b) To an astronaut sky appears dark instead of blue. Give the reason.

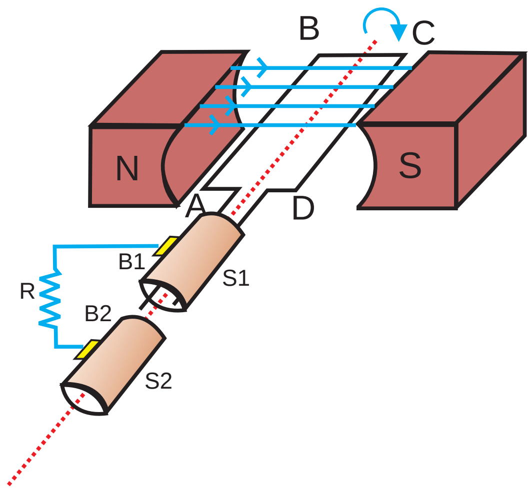
PART – C



1. (a) Label the following in the given diagram given below.

a) Incident ray b) Refracted ray
c) Emergent ray d)Angle of refraction
e) Angle of deviation f) Angle of emergence

1. (b) The retractive index of diamond is 2.42. What is the meaning of this statement in relation to speed of light?



2. a) Re draw the above diagram.

b) This diagram represents __________

c) Label the parts of the diagram.

d) Write the principle of the name of the device denoted by this diagram.

FURTHER REFERENCE

Books: 1. Fundamentals of optics
D.R. Khanna and H.R. Gulati R.Chand & Co

2. Magnetism **Joy Frisch** - Schnoll published by Creative Eduction.

3. Advanced physics **Keith Gibbs** Cambridge University press

Website: www.physics about.com

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CHAPTER 17

SYLLABUS

1.	**Applied Biology**	**Heredity and Evolution :-** Heredity –Variations-Evolution-Speciation-Human evolution-Evolution tree-Genetic engineering-Bio technology and cloning-Stem cell-Organ culture-Microbial production-Biosensor – Bio chips-Science today – Gene therapy
2.	**Health and Hygiene**	**Immune System:-** Health and its significance-Diseases and causes-Diseases caused by microbes and prevention-Modes of transmission-Immunization-Treatment and prevention-Biotechnology in Medicine-HIV and Prevention
3.	**My Body**	**Structure & Function of the Human Body – Organ System:-** Nervous system-Endocrine system-Cell division-Stages of Meiosis-Heredity
4.	**World of Plants**	**Reproduction in Plants:-**Modes of reproduction - vegetative, asexual and sexual reproduction in plants-Pollination-Fertilization-Fruits and seeds formation-Seed dispersal
5.	**World of Animals**	**A Representative Study of Mammals-** Morphology-Habitats-Adaptations-Basic Physiological Functions.-Circulatory system in man-Excretory system in man.-Relationship of structure to functions-Animal Behaviour - Behaviour (social, reproductive, parental care) -Some case studies from researchers(animals behavior)
6.	**Life Process**	**Life Processes:-** Definition-Types of nutrition and human digestive system-Respiration -Transportation in plants-water and minerals and animals - blood circulation-Excretion in plants and animals-Nervous system-Coordination in plants-Movement due to growth-Hormones in animals
7.	**Environmental Science - Ecology**	**Conservation of Environment:-** Bio degradable and non bio degradable wastes-Water management-Wild life sanctuaries-Balance in Ecosystem-Coal and petroleum-Green chemistry-Science today – Towards a global village
8.	**Environmental Science – Resource use and Management**	**Waste Water Management:-** Journey of water-Sewage -Treatment -Domestic practices -Sanitation and diseases-Alternate arrangement for sewage disposal -Sanitation in public places-Energy Management-Energy audit (home, school)- Renewable sources (solar, hydrogen, wind)- Non–renewable sources—(coal, petroleum, natural gas)- Bio-fuels-generation & use-Energy Conservation & How we can help.
9.	**Matter**	**Solutions:-** Solute and Solvent-Types of Solutions-Solubility-Factors affecting – Solubility-Problems
10.	**Atomic Structure**	**Atoms and Molecules:-** Modern atomic theory-Avogadro Hypothesis-Atomicity-Relation between vapour density and molecular mass of a gas- Difference between-Atom and Molecules-Relative Atomic Mass-Relative Molecular mass-Mole Concepts- Mole- Definition-Problems based on mole concept

11.	**Exploring Chemical Changes and Formulation**	**Chemical Reactions:-** Types of chemical reactions -Rate of chemical reaction-Factors influencing the rate of the chemical reaction-Acids-Classification of acids- Chemical properties of acids-Uses of acids-Bases-Classification of bases-Chemical properties of bases- uses of bases-Identification of acids and bases-pH scale-pH paper-Importance of pH in everyday life-Salts- Classification of salts-Uses of salts
12.	**Exploring Chemical Families**	**Periodic Classification of Elements:-** Modern periodic law-Modern periodic table-Characteristics of modern periodic table-Metallurgy –Introduction-Terminologies in metallurgy-Differences between Minerals and Ores-Occurrence of metals- Metallurgy of Al, Cu and Fe- Metallurgy of Aluminium-Metallurgy of Copper- Metallurgy of iron- Alloys- Methods of making alloys-Copper Aluminium and Iron alloys-Corros ion -Method s of preventing corrosion
13.	**Exploring the World**	**Carbon and its Compounds:-** Introduction-Compounds of carbon-Modern definition of organic chemistry-Bonding in carbon and its compounds-Allotropy- Physical nature of carbon and its compounds- Chemical- properties of carbon compounds-Homologous series-Hydrocarbons and their types -Functional groups- Classification of organic compound based on functional group-Ethanol-Ethanoic acid
14.	**Matter and Measurement**	**Measuring Instruments:-** Screw Gauge-Measuring long-Distances – Astronomical distance, light year
15.	**Forces and Movement**	**Laws of Motion and Gravitation-**Balanced and imbalanced forces-First law of motion-Inertia and mass-Momentum-Second aw of motion-F=ma-Third law of motion-Conservation of momentum and proof-Moment of force and couple-Gravitation Newton’s law of gravitation –Mass- Weight-Acceleration due to gravity-Mass of Earth-Science Today- Chandrayan, Cryogenic Techniques and Manned Space Station
16.	**Exploring Energy**	**Electricity and Energy:-** Electric current and circuit-Electric potential and potential difference-Circuit diagram-Ohm’s law-Resistance of a conductor-System of resistors -Heating effect of electric current-Joules law of heating-Role of fuse-Domestic electric circuits-Electric power-Chemical effect of electric current-Electrolysis electro chemical cells-Primary and Secondary cells-Sources of Energy-Conventional sources of energy-Non- conventional source of energy- Nuclear energy-Radioactivity-Nuclear fission and nuclear fusion-Nuclear reactivity advantages-Hazards of nuclear energy-Science today – Energy from seas.
17.	**Exploring Phenomena**	**Magnetic Effect of Electric Current and Light :-**Magnetic field and magnetic lines of force-Magnetic field due to current carrying conductor-Magnetic field due to current carrying Straight conductor- Magnetic field due to current carrying Circular loop-Force on a current carrying conductor in a magnetic field-Fleming left hand rule -Electric motor-Electromagnetic induction- Faraday’s experiments-Electric generator –Light-Reflection of light by Spherical mirrors – image formation and Mirror Formula - Refraction – Laws of refraction-Refractive index-Refraction by spherical lenses- Image formation by lenses-Lens formula and magnification-Power of lens-Refraction of light through a prism-Dispersion-By a glass prism-Atmospheric refraction- Human eye –Defects and rectification-Science today –Hubble space telescope
18.	**Technology**	Practical and Projects

Design of Question Paper – X Std Science (Theory)

Time: 2½ Hours **Max. Marks: 75**

The weightage of marks allotted for the design of question paper shall be as under:

A. Weightage to Learning Outcome

Sl.No	Categories	Mark	PERCENTAGE
1	Knowledge	17	15
2	Understanding	52	45
3	Application	35	30
4	Skill	11	10
	Total	**115**	**100**

Note: (1) Total Marks is 115 inclusive of choice. (2) While preparing the question paper, there may be variations in weightage to the extent from 2 % to 5 %.

B. Weightage given to various types of question

S.No	Types of Questions	Marks for Each Question	Total No. of Questions	No. of Questions to be answered	Total Marks
1	Section A Objective Type (OT)	1	15	15	15x 1=15
2	Section B Short Answer (SA)	2	30*	20	20x2 = 40
3	Section C Long Answer (LA)*	5	8	4	4 x 5 = 20
		Total	**53**	**39**	**75**

* Each Question may be split into 2 or 3 sub-divisions carrying 1, 2 or 3 marks. But the questions shall be from each area (Botany, Zoology, Chemistry, Physics). Choices will be internal (Either - or)

*Short Answer split up

Sl.No.	Very Short Answer Type of Questions	To be asked
1	To Match	3
2	To spot the error / mistake in the given statements	3
3	Reason and Assertion	3
4	To Raise questions	3
5	To label the parts in the given diagram	3
6	To copy a diagram & to identify /mark the parts	3
7	To calculate the required value(Problem solving)	3
8	To fill up the blanks (from the given pair of answers)	3
9	To interpret what happens in the given situations	3
10	To find the odd one out	3
	Total Number of Questions given	30
	Total Number of Questions to be answered	20

C. Weightage given to the higher order of questions

Sl.No	Estimated higher order of questions	% Percentage
1	Easy	50
2	Average	40
3	Difficult	10

D. Weightage to Content Unit

Units			No. of Questions			Total Marks
		OT	SA	LA		
1. Heredity and Evolution	Botany and Zoology	1(1)	1(2)	1(5)	23	8
2. Immune System		1(1)	1(2)	1(5)		8
3. Structure & Function of the Human Body – Organ System		-	3(2)	-		6
4. Reproduction in Plants		1(1)	1(2)	1(5)		8
5. A representative Study of Mammals		-	3(2)	-		6
6. Life Processes		1(1)	1(2)			3
7. Conservation of Environment		1(1)	1(2)	1(5)		8
8. Waste Water Management		-	3(2)	-		6
9. Solutions	Chemistry	1(1)	2(2)	-	15	5
10. Atoms and Molecules		-	1(2)	1(5)		7
11. Chemical Reaction		1(1)	2(2)			5
12. Periodic Classification of Elements		2(1)	2(2)			6
13. Carbon and its Compounds		1(1)	1(2)	1(5)		8
14. Measurements					15	-
15. Laws of Motion and Gravitation	Physics	1(1)	2(2)	1(5)		10
16. Electricity and Energy		2(1)	3(2)			8
17. Magnetic Effect of Electric Current and Light		2(1)	3(2)	1(5)		13
Total Number of Questions given		15(15)	30(60)	8(40)	53	115
Total Number of Questions to be answered		15(15)	20(40)	4(20)	39	75

() Indicates the marks

BLUE PRINT

Unit No.	Content Unit	Related Subject	Knowledge			Understanding			Application			Skill			Total No. of Questions	Total Marks
			OT	SA	LA	OT	SA	LA	OT	SA	LA	OT	SA	LA		
1	Heredity and Evolution	Zoo	1(1)				1(2)				1(5)				3	8
2	Immune System	Zoo	1(1)					1(5)		1(2)					3	8
3	Structure & Function of the Human Body Human Body – Organ System	Zoo					1(2)			1(2)			1(2)		3	6
4	Reproduction in Plants	Bot	1(1)					1(5)					1(2)		3	8
5	A Representative Study of Mammals	Zoo		1(2)			1(2)			1(2)					3	6
6	Life Processes	Bot & Zoo				1(1)	1(2)								2	3
7	Conservation of Environment	Bot				1(1)					1(5)		1(2)		3	8
8	Waste Water Management	Bot					2(2)			1(2)					3	6
9	Solutions	Che				1(1)	1(2)			1(2)					3	5
10	Atoms and Molecules	Che			1(5)					1(2)					2	7
11	Chemical Reaction	Che		1(2)		1(1)	1(2)								3	5
12	Periodic Classification of Elements	Che	1(1)			1(1)	1(2)			1(2)					4	6
13	Carbon and its Compounds	Che				1(1)		1(5)		1(2)					3	8
14	Measurements	Phy													-	-
15	Laws of Motion and Gravitation	Phy		1(2)			1(2)	1(5)	1(1)						4	10
16	Electricity and Energy	Phy		1(2)		1(1)	1(2)					1(1)	1(2)		5	8
17	Magnetic Effect of Electric Current and Light	Phy				1(1)	1(2)		1(1)	1(2)	1(5)		1(2)		6	13
	Total		4(4)	4(8)	1(5)	8(8)	12(24)	4(20)	2(2)	9(18)	3(15)	1(1)	5(10)	-	53	115

SCIENCE PRACTICALS

S.No	Content
	Biological Science (Zoology & Botany)
1	To find out the presence of starch in the given food samples of A and B by using iodine solution.
2	To find out the rate of heart beat of human beings by using stethoscope under normal physical conditions.
3	To find out the body temperature by using clinical thermometer and to compare with surrounding temperature.
4	To calculate is the Body Mass Index (BMI) of a person, by using the BMI formula and to compare the value with BMI chart.
5	To dissect and display the androecium and gynoecium of any locally available flowers.
6	To classify the fruits,separating the pericarps and writing the edible parts.
7	To identify the structure of ovule.
8	To prove the anaerbic respiration (Fermentation).
	Physical Science (Chemistry & Physics)
9	To find the pH of a given solution using pH paper.
10	To identify the presence of acids and bases in a given solution.
11	Preparation of true solution, colloidal solution and suspension.
12	To predict whether the reaction exothermic or endothermic.
13	Screw cauge-measuring small dimensions.
14	Resistance of a coil of wire,
15	To map of magnetic field of a bar magnet when its north pole pointing north of the earth.
16.	Focal length of a convex lens by distance object method.
	Record the findings directly in the table provided.

Zoology

Ex. No. 1 **Date :**

To find out the presence of starch in the given food samples of A and B by using Iodine solution.

Aim:

To find out the presence of starch in the given food samples of A and B by using iodine solution.

Requirements:

Test tubes, Iodine solution.

Procedure:

Take 1 ml of foood sample A and B in separate test tubes.

Add one drop of Iodine solution in bothe the test tubes.

Observe the colour change and record.

Indication : Appearence of dark blue colour indicates the presence of starch.

Table:

Sl.No	Food Sample	Observation	Presence / Absence of Starch
1	A		
2	B		

Result:

The food sample____________________contains starch.

Ex. No. 2 **Date :**

To find out the rate of heart beat of human beings by using stethoscope under normal physical conditions.

Aim:

To find out the rate of heart beat of a person by using stetheoscope.

Requirements:

Stethoscope, stop watch.

Procedure:

Use the stethoscope and hear Lubb and Dubb sound which make up a heart beat.

Count the number of heart beats per minute and record.

Table:

Sl. No	Persons	No. of heart beat per minute
1	A	
2		
3		
4		
5		
	Average :	

Inference:

Under normal conditions the average human heart beat is found to be ______ per minute.

Ex. No. 3 **Date :**

To find out the body temperature by using clinical thermometer and to compare with surrounding temperature.

Aim:

To find out the body temperature of human being using clinical thermometer.

Requirement:

Clinical thermometer, lab thermometer

Procedure:

Find out the room temperature by using lab thermometer.

Clean the Clinical thermometer in dilute dettol soaked cotton.

Shake the clinical thermometer at least four times.

Keep the mercury bulb of the clinical thermometer at the arm pit in boys or elbow in girls for a minute and record the temperature.

Repeat the same outside the room and record your findings for atleast three of your friends.

Table:

S.No	Test	Body Temperature ^{o}F	Room Temperature ^{o}C	C=F-32 x 5/ 9
1	Inside the room Outside the room			
2	Inside the room Outside the room			
3	Inside the room Outside the room			

Inference:

Under normal conditions the body temperature of human beings is ______^{o}F, ______^{o}C.

The body temperature of human beings remains the or same/ varies irrespective of surroundings.

SCIENCE

Ex. No. 4 **Date :**

To calculate the Body Mass Index (BMI) of a person, by using the BMI formula and comparing the value with BMI chart.

Aim:

To calculate the BMI of any one of your classmates by using the BMI formula.

Requirements:

Weighing machine, measuring tape.

Procedure:

Find out the weight in kg of your calssmate by using weighing machine.

Find out the height of the same person and convert into meter^2

By using the formula

$$BMI = \frac{\text{weight in kg}}{\text{height in } m^2}$$

Find out the BMI and record.

Note:

BMI 19-25 is normal , 26 and above is obese, below 19 is lean.

Table:

Sl. No	Persons	weight in kg	Height in meter	Height in meter^2	BMI
1					
2					
3					

Inference:

The BMI of my classmate Selvan/Selvi _______________is ________ and so he/she is normal / obese / lean.

Botany

Ex. No. 5 **Date :**

To dissect and display the androecium and gynoecium of any locally available flowers.

To dissect and display the androecium and gynoecium of any locally available flowers.

Androecium

1) Androecium is the male reproductive part.
2) It has two parts, the filament and anther.
3) Pollen grains develop inside the anther.

Gynoecium

1) Gynoecium is the female reproductive part.
2) It has three parts, the ovary style and stigma.
3) Ovules are seen inside the ovary.

Separate the Androecium and Gynoecium of a given flower and paste in a separate sheet. Record your observations with regard to number of stamen shape of anther and shape of stigma in the given table.

Sl.no	Name of the flower	Androecium	Gynoecium
1.			
2.			
3.			
4.			
5.			

Ex. No. 6 **Date :**

To classify the fruits. Separate the pericarps and write the edible parts and fill in the blanks

Simple fleshy fruits

Berry - Tomato

1) The pericarp is divided into ______________ and ______________.
2) The mesocarp and endocarp remain ______________.
3) The edible part in tomato is ______________.

Berry - Banana

1) The pericarp is divided into ______________ and ______________.
2) The epicarp is ______________ and the mesocarp is ______________.
3) The edible part in banana is ______________.

Hesperidium - Orange/Lemon.

1) The pericarp is differentiated into ______________ layers.
2) The outer glandular skin is ______________.
3) A middle thin whitish layer is ______________.
4) An inner membranous part is ______________.
5) The juicy hairs or out growths are ______________.

Pepo - Cucumber/ivy gourd (Kovai)

1) The pericarp is ______________ and ______________.
2) The mesocarp is ______________.
3) The edible part is ______________

Drupe – Mango

1) The number of seeds in mango is ______________.
2) Pericarp is differentiated into epicarp, ______________, ______________ and ______________
3) Epicarp is s______________, mesocarp is ______________ and endocarp is ______________ in nature.
4) Edible part of the mango is ______________.

Drupe – Coconut

1) The pericarp is differentiated into ______________, ______________ and ______________.
2) The epicarp is thick, the mesocarp is ______________, and the endocarp is hard.
3) The endosperm seen inside the ______________ is edible.

Classify the given fruits, record your observations in the given table.

Sl. No.	Type of fruit of fruit	Nature of pericarp	Edible part
1.			
2.			
3.			

Ex. No. 7 **Date :**

To identify the structure of ovule.

The given slide kept for identification is L.S. of ovule

The charecteristics of ovule :

1) The ovule has ____________ layers of walls called as integuments.
2) Inner to the integuments, ____________ is present.
3) The embryo sac has ____________, ____________ and ____________

Observe the given slide and record your observations in the table :

Sl.No	Observation
1.	
2.	
3.	

Ex. No. 8 **Date :**

To prove the anaerbic respiration (fermentation).

Aim:

To prove the anaerobic respiration(fermentation)

Materials required:

Test tube, sugar solution, yeast.

Procedure:

Sugar solution in a test tube is taken. A little quantity of yeast is added.

The tube is placed in a warm place–sunlight.

Record your observations and inference in the table given below :

Observation	Inference

Results: The alcohol smell indicates that the sugar is converted into alchohol in the fermentation process

Chemistry

Ex. No. 9 **Date :**

To find the pH of a given solution using pH paper.

Aim:

To find the pH of the given solution using pH paper.

Materials and Apparatus required:

Test tubes, test tube stand, test tube holder, pH paper, dil. HCl, dil. NaOH, lemon juice, water, baking soda solution, vinegar etc.

Procedure:

Take about 10 ml of the given samples in different test tubes and label them as A, B, C, D, E and F. Dip the pH paper into the test tubes and compare the colour of pH paper with the colour chart of pH reference. Note the approximate value of pH.

Table:

Test tubes	Sample	pH paper		Nature of solution
		Colour produced	Approximate pH	Acidic/Basic/Neutral
A				
B				
C				
D				
E				
F				

Ex. No. 10 **Date :**

To identify acids and bases

Aim

To identify the presence of an acid or a base in a given sample.

Materials and apparatus required :

Test tubes, test tube stand, glass rod, litmus paper (both red and blue), acids, bases, phenolphthalein, methyl orange solution.

Note:

- All acidic solutions are colourless in phenolphthalein, pink in methyl orange and turn blue litmus paper to red.
- All basic solutions are pink in phenolphthalein, straw yellow in methyl orange and turn red litmus paper to blue.

S.No	Experiment	Observation (Colour change)	Inference (Acid/base)
1	Take 5 ml of the test solution in a test tube, add phenolphthalein in drops to this content.		
2	Take 5 ml of the test solution in a test tube and add methyl orange in drops.		
3	Take 10 ml of the test solution in a test tube and dip litmus paper into the test tube.		

Ex. No. 11 **Date :**

Preparation of true solution, colloidal solution and suspension

Aim :

To prepare true solution, colloidal solution and suspension

Materials and apparatus required :

Beakers, common salt, table sugar, starch, chalk powder, sand, egg albumin.

Procedure: Take 20ml of water in three different beakers and label them as A, B & C. Add common salt in A, starch in B, and chalk power in C. Stir the contents of three different beakers gently. Record your observations.

Beaker	Observation	Inference
A.		
B.		
C.		

Note :

i. If the particles do not settle down at the bottom and pass through the filter paper easily the solution is said to be a true solution.

ii. If the particles do not settle down but they form turbid solution then the solution is said to be a colloidal solution.

iii. If the particles settle down to form sediments leaving behind residue on the filter paper then the solution is said to be a suspension.

Result : True solution is in beaker ______________

Colloidal solution is in beaker ___________

Suspension is in beaker _______________

Ex. No. 12 **Date :**

To predict whether the reaction is exothermic or endothermic.

Aim.

To predict whether a reaction is exothermic or endothermic using the given chemicals

Materials and apparatus required

Test tubes, test tube stand, water, glass rod, sodium hydroxide (pellets),ammonium chloride etc.

Note:

- **Exothermic reaction evolves heat**
- **Endothermic reaction absorbs heat**

S.No	Experiment	Observation(hot/cold)	Inference (exo/endo)
1	Take water in a test tube. Add sodium hydroxide pellets one by one followed by stirring. Touch the test tube and note the observation.		
2	Take water in a test tube. Add ammonium chloride salt and stir well .Touch the test tube and note the observation.		

Ex. No. 13 **Date :**

SCREW GAUGE - Measuring small dimensions of the object

Aim:

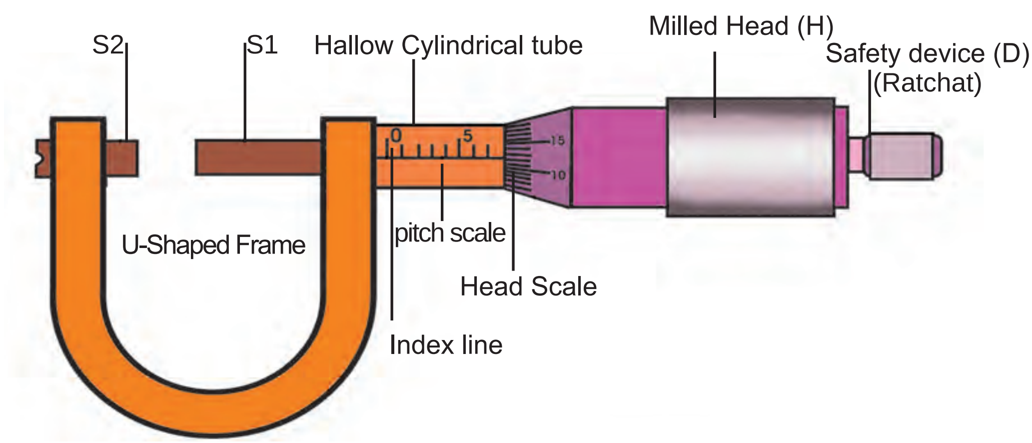
To find the radius of the given wire.

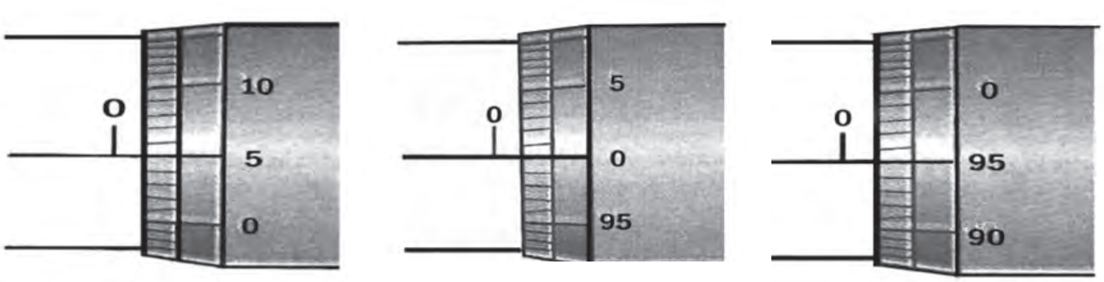
Apparatus required :

Screw gauge, a uniform thin metal wire.

Formula :

Radius of the wire r = d/2, d – diameter of the wire.





Procedure :

The least count of the screw gauge is found .Zero error of the screw gauge is found in the following way. The plane surface of the screw and the opposite

plane stud on the frame are brought in to contact. If zero of head scale coincides with the pitch scale axis, there is no zero error.

If the zero of the head scale lies below the pitch scale axis, the zero error is positive. If the n th division of the head scale coincides with the pitch scale axis

ZE = + (n × LC)

Then the zero correction ZC = - (n × LC)

If the zero of the head scale lies above the pitch scale axis, the zero error is negative. If the n th division of the head scale coincides with the pitch scale axis

ZE = - (100 – n) × LC

Then the zero correction ZC = + (100 – n) × LC

Place the wire between two studs. Rotate the head until the wire is held firmly but not tightly . Note the pitch scale reading(PSR) and the head scale division which coincides with the pitch scale axis (HSC). The diameter of the wire is given by PSR + (H.S.C × LC) + ZC. Repeat the experiment for different portions of the wire. Tabulate the readings. The average of the last column readings gives the diameter(d) of the wire.The value d/2 gives the radius of the wire.

Table:

L.C = **Z.E =** **Z.C =**

S.No	P.S.R (mm)	H.S.C	H.S.C × L.C	Total reading P.S.R +(H.S.C ×L.C) ± Z.C (mm)
1				
2				
3				
			Mean =	

The radius of given wire r = d/2

Result :

The radius of the given wire = mm

Ex. No. 14 **Date :**

RESISTANCE OF A WIRE

Aim

To determine the resistance of the given wire .

Apparatus required

A battery(2 V), ammeter(1.5 A), voltmeter(1.5 V), key, rheostat, experimental wire(1 Ω or 2 Ω) and connecting wires.

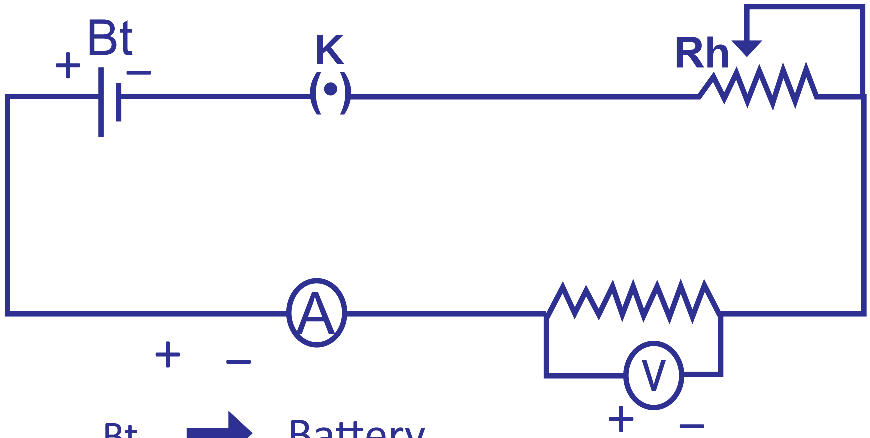
Formula

Resistance of the wire $R = \frac{V}{I}$

V is the potential difference across the wire.

I is the strength of the current through the experimental wire.

Circuit diagram:



Bt → Battery
K → Key
Rh → Rheostat
A → Ammeter
R → Resistance (unknown)
V → Voltmeter

Procedure

Connect the battery eliminator, ammeter the given wire, rheostat and key in series. The voltmeter is connected in parallel connection across the given wire. The circuit is closed and the rheostat is adjusted such that a constant current flows through the given coil of wire. The current is noted as 'I' from the ammeter and the potential difference across the wire V is noted from the voltmeter. The value V/I gives the resistance of the wire. The experiment is repeated for different values of the current.

The average value of $\frac{V}{I}$ gives the resistance of the wire R.

Tabulation

Trial No	Ammeter reading I (ampere)	Voltmeter reading V (volt)	Resistance R = V/I (ohm)
1			
2			
3			
4			
5			

Mean R =

Result

Resistance of the given wire R = ———— ohm.

SCIENCE

Ex. No. 15 **Date :**

MAPPING OF MAGNETIC FIELD

Aim:

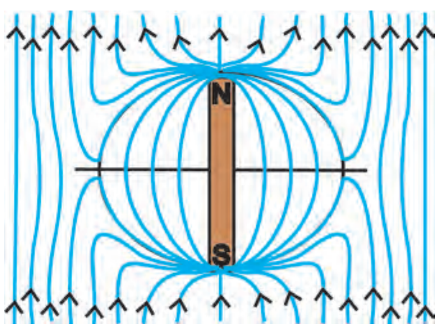
To map the magnetic lines of force when the bar magnet is placed with its north pole facing geographic north

Apparatus required:

Drawing board, drawing pins, bar magnet, small magnetic compass needle and white sheet.

Procedure:

A sheet of paper is fixed on a drawing board. Using a compass needle, the magnetic meridian is drawn on it. A bar magnet is placed on the magnetic meridian such that its north pole points towards geographic north. The north and south poles of the compass are marked by pencil dots. The compass needle is shifted and placed so that its south pole touches the pencil dot marked for the north pole. The process is repeated and a series of dots are obtained. The dots are joined as a smooth curve. This curve is a magnetic line of force. In the same way several magnetic lines of force are drawn around the magnet as shown in figure. The magnetic lines of force is due to the combined effect of the magnetic field due to bar magnet and the Earth.



Result:

The magnetic lines of force are maped when the bar magnet is placed with its north pole facing geographic north. The maped sheet is attached.

Ex. No. 16 **Date :**

FOCAL LENGTH OF CONVEX LENS

Aim

To determine the focal length of convex lens by distant object method

Apparatus required

The given convex lens, lens stand, white screen and meter scale

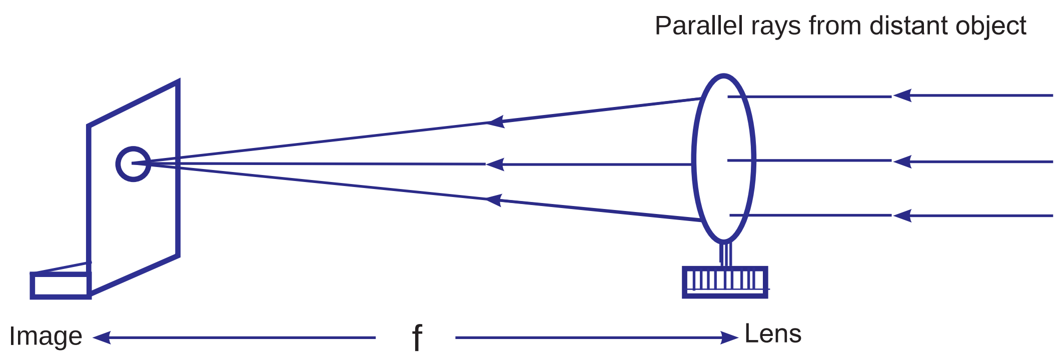
Procedure

$$\text{Formula : Focal length } f = \frac{f_1 + f_2 + f_3}{3}$$

f_1, f_2, f_3, are the focal lengths measured by focucing different distant objects.

Distant object method

The convex lens is mounted on the stand and is kept facing a distant object (may be a tree or a building). The white screen is placed behind the convex lens and its position is adjusted to get a clear, diminished and inverted image of the object. The distance between the convex lens and the screen is measured. This gives an approximate value of the focal length of the convex lens.



S.No	Distant object	Distance between the convex lens and the screen
1	Tree	f_1
2	Building	f_2
3	Electric pole	f_3
	Mean =	

.

Result:

Focal length of the given convex lens f = ————————————-cm

SCIENCE